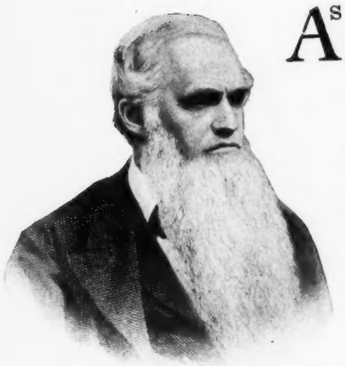
MACHINERY

July, 1910

HISTORY OF THE INVENTION OF THE UNIVERSAL GRINDING MACHINE

By LUTHER D. BURLINGAME



Joseph R. Brown, born January 16, 1810, died July 23, 1876

As far as the writer knows the early history of the universal grinding machine has never been recorded in print. This machine is one which has had such an influence on modern machine methods and has done so much to raise the standard of workmanship and to increase economy of production that it is believed that its history should be recorded while the records still exist and while the memory of living men can be drawn upon for the facts necessary to complete it.

In investigating this matter it has been interesting to trace the progress from the crude grinding lathe of the early 60's, step by step, to a complete universal machine, a progress with which Mr. Joseph R. Brown, senior member of the firm then doing business under the name of J. R. Brown & Sharpe, was intimately connected in all its steps.

The grinding machine as first built at the Brown & Sharpe works was for the accurate and economical manufacture of their own products without thought of putting the machines on the market. In this respect, its origin and development were very much like the origin and development of the universal milling machine and other machine tools which have originated in the works of this company. The first work for which the grinding machines were designed was for grinding needle bars, foot bars, and shafts of the Wilcox and Gibbs sewing machine. This was done by mounting an emery wheel on the carriage of a lathe and traversing it back and forth past the work.

Old Shop in South Main St., Providence, R. I., where the Universal Grinding Machine was invented and first built

In 1864 and 1865 drawings were made and machines built using parts of a 14-inch Putnam lathe, mounting a wheel stand as above mentioned and adding a feeding mechanism including a reverse. One of these early machines is still in use in the Brown & Sharpe works, although the feed mechanism and footstock have been removed. It is now used for grinding the faces of dies. This machine in its present form is shown in Fig. 1. It bears an old brass plate stamped "Grinding Machine by J. R. Brown & Sharpe." The construction of the wheel stand and feed mechanism of this machine is shown in Fig. 2 and Fig. 6 reproduced from the original drawings.

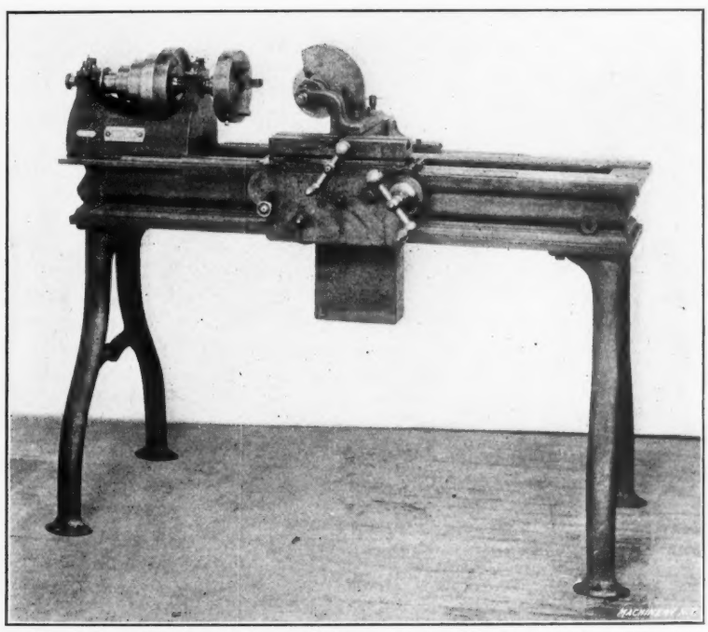


Fig. 1. One of the Original Brown & Sharpe Grinding Machines—a 14-inch Putnam Lathe converted for the Purpose

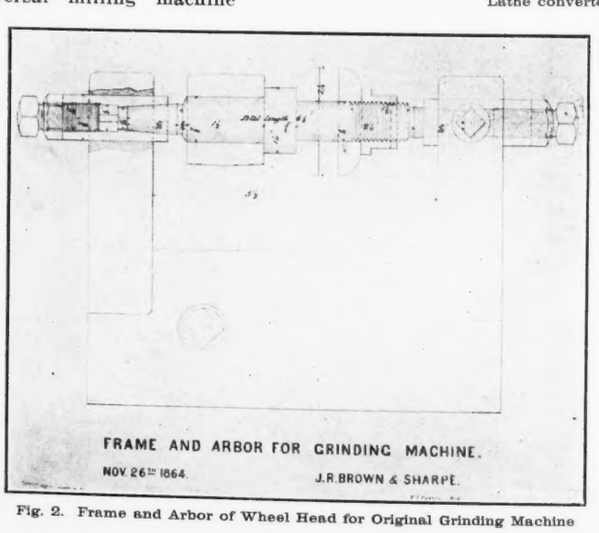
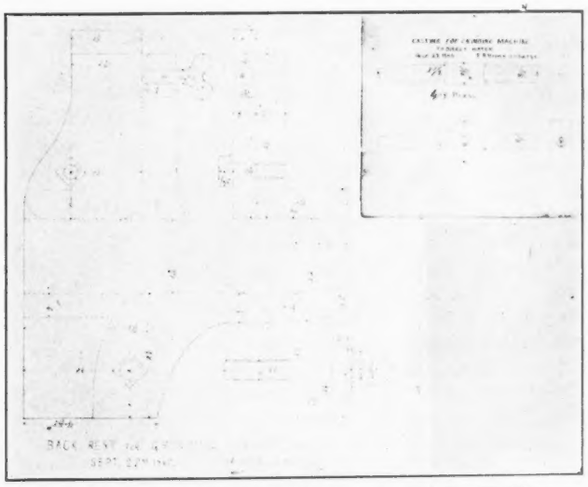


Fig. 2. Frame and Arbor of Wheel Head for Original Grinding Machine



Figs. 3 and 4. Back-rest and Water Spout for Grinding Machine

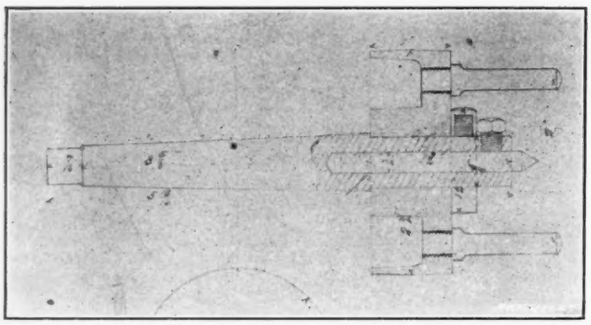


Fig. 5. Dead Center Pulley for Grinding Machine

That cylindrical grinding was done in the Brown & Sharpe works at an earlier date than that of these drawings is indicated by the drawing of a back-rest dated September 22, 1862, which contains the essential features of a solid back-rest of to-day. This is shown in Fig. 3. A spring back-rest was also used for finishing and was applied by having a spring rod extending from the footstock, this rod carrying leather washers which pressed against the work. Skill in adjusting this back-rest was required to prevent chattering. A dead center pulley, an important step in the development of the grinding art, is shown in Fig. 5, reproduced from a drawing made in 1864. Wet grinding was done on these early machines by using a wet sponge held by hand against the work. The sparks were quenched in a dish of water placed below the work. Later a supply of water was provided through a nozzle shown in a drawing dated December 22, 1866, Fig. 4.

During the next few years about thirty of these machines were built and sold, the same plan being followed of using Putnam lathes, partly dismantled. These were bought ready to apply the parts which were built and applied at the Brown & Sharpe works. The first machine was sold to the Leavitt Sewing Machine Co. of Boston, Mass., in July, 1865; the second one was sold to Charles Callefaut, Paris, France, and included apparatus for grinding bevel cutters. Several of these machines were in constant use in the shops of J. R. Brown & Sharpe on the sewing machine parts, but work kept piling up ahead of them and could not be hurried as a considerable amount of time and a high degree of skill were required to produce work of a sufficiently high standard on such machines. There were also many kinds of work where finishing by grinding would be an advantage, but which could not be done on this machine. During these years Mr. Brown had constantly in mind the need of building a machine designed from the floor up especially for grinding, and he considered the matter to such good purpose, that in 1868 he had a drawing made of such a machine. This drawing shows a machine containing most of the essential elements of the universal grinding machine of to-day. Un-

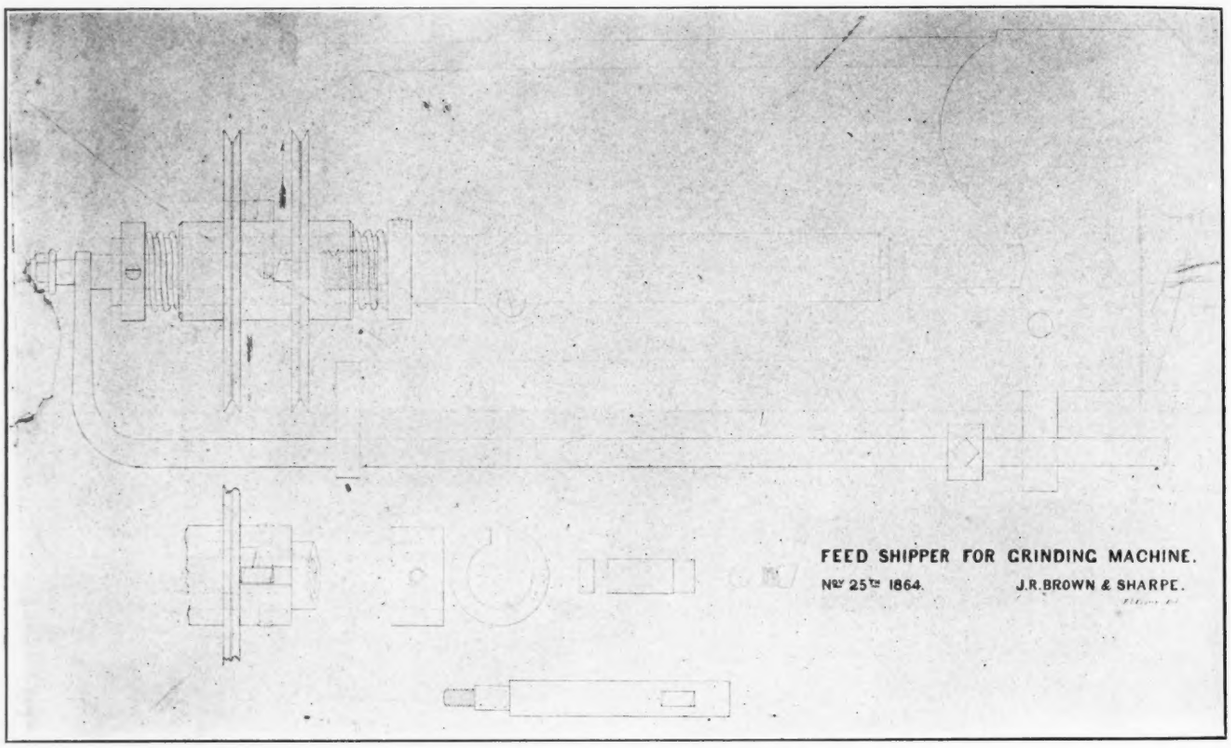


Fig. 6. Feed Shipper for Original Grinding Machine

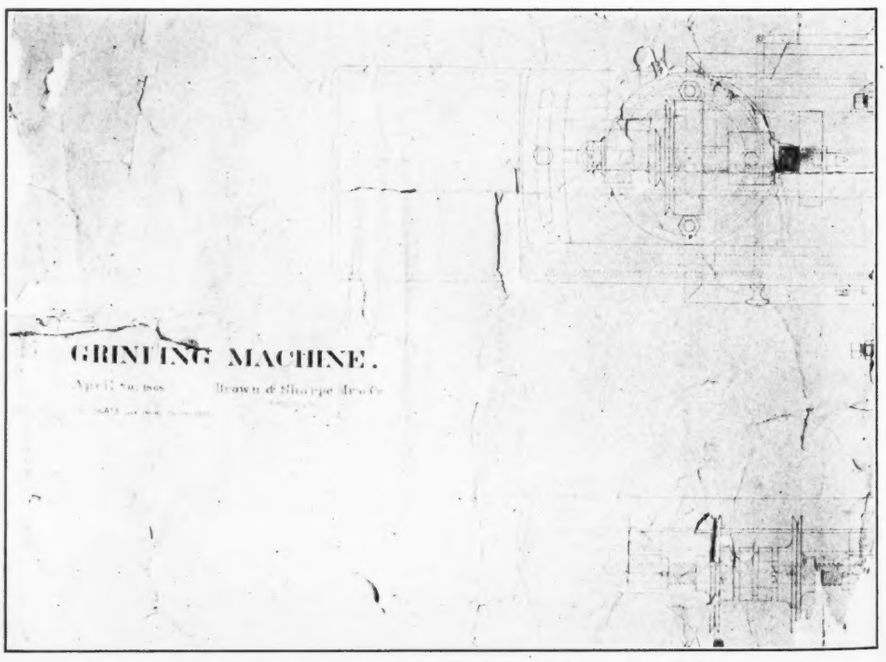


Fig. 7. Part of Mutilated Drawing of Grinding Machine made in 1868

fortunately it is made with the fine lines which, in those days, were considered the marks of an expert draftsman, and the drawing is also much the worse for wear. Its historic interest is such, however, that parts of it are here shown in Figs. 7 and 8. This machine has the same wheel stand as that of the earlier grinding lathe shown in Fig. 2, but instead of having the wheel travel, there is a sliding table carrying a swivel table on which are mounted the headstock and footstock, the headstock also being arranged to swivel. This drawing did not, however, show a machine having a swivel wheel stand.

As far as known, none of these machines were built at this time on account of pressure of other matters, but in 1874 working drawings were made for a machine which included a swiveling wheel stand as well as other features of improved construction. One of the drawings of this machine is shown in Fig. 10. This drawing shows stops on the cross-feed handwheel, a feature which had been previously used on the earlier grinding lathe, but of which no record could be found. The machine shown in Fig. 10 also indicates some attempt at providing for carrying off the water used in grinding. An interesting feature of the wheel spindle of this machine shown in Fig. 11 is that its bearings and boxes being of hardened steel and having double tapers would seem to require the use of a universal grinding machine to produce them. It would be an interesting bit of history to know just how the first ones were produced. It is hard for us in these days to appreciate just what our ancestors had to contend with in obtaining results without the machines and tools which we consider essential to-day. One of the machines of this design was sold to E. Cornely, Paris, France, on January 3, 1876. This, however, was not the first machine built, the first machine being reserved to be exhibited at the Centennial Exposition in 1876. It was sold at the close of the exposition to M. M. Heilman-Ducommun & Steinlen, Mulhouse, Alsace, Germany. The first machine sold in America was to the Whitehill Mfg. Co., of New York City, the following year.

The judges at the Centennial Exposition, in commenting on the Brown & Sharpe exhibit, after speaking of the machines in general which they said "are characterized by great neatness of design and excellence of execution," continued: "Their universal grinder is an exceedingly substantial and well studied machine whose working details are exceptionally well managed for facilitating the work it is to perform."

In a history of the Centennial Exposition by Thomas Bentley, published in 1876, is shown a cut of this first universal grinding machine, which is here reproduced in Fig. 12. The comments of the author may be of interest as showing an appreciation of the trend of the times and as something of a prophecy. He says of the Brown & Sharpe exhibit:

"The superior class of tools here represented are of a character fitted to elevate the standard of workmanship in connection with machine shop manipulation. Accurate tools like these produce accurate and interchangeable work, cheapening production and at the same time giving that perfection which is becoming more and more indispensable in the sharp competition attending the manufacture of machinery. The machines themselves illustrate this in their fine workmanship and finish, and in the nice adaptability of their motion and parts to produce the required work."

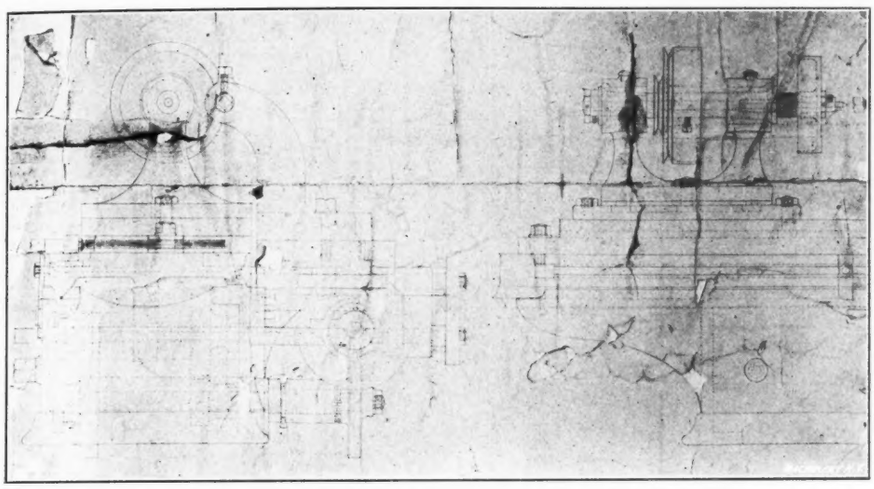


Fig. 8. Another Part of Mutilated Drawing of Grinding Machine made in 1868

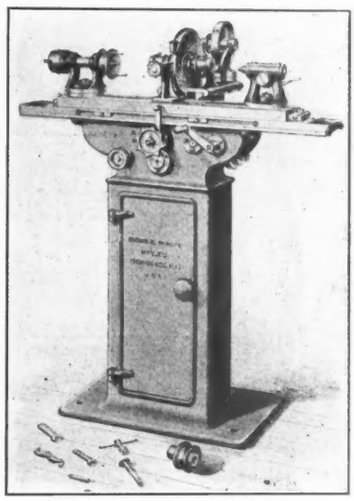


Fig. 9. "The Baby Grinder"

On the death of Mr. Brown in 1876, application was made by his executors for a patent on the universal grinding machine, and it was issued on February 27, 1877. Figs. 1, 3 and 4 of this patent are here reproduced as Figs. 13 and 14, and give a fair idea of the mechanism of the machine as it existed at that date. It will be noticed that these patent office drawings show a machine for form grinding, in addition to the ordinary features of a universal machine. A smaller machine was designed a few years later, which is shown in Fig. 9. This was known for many years in the shop as the "Baby Grinder," a name which still persists among older employes.

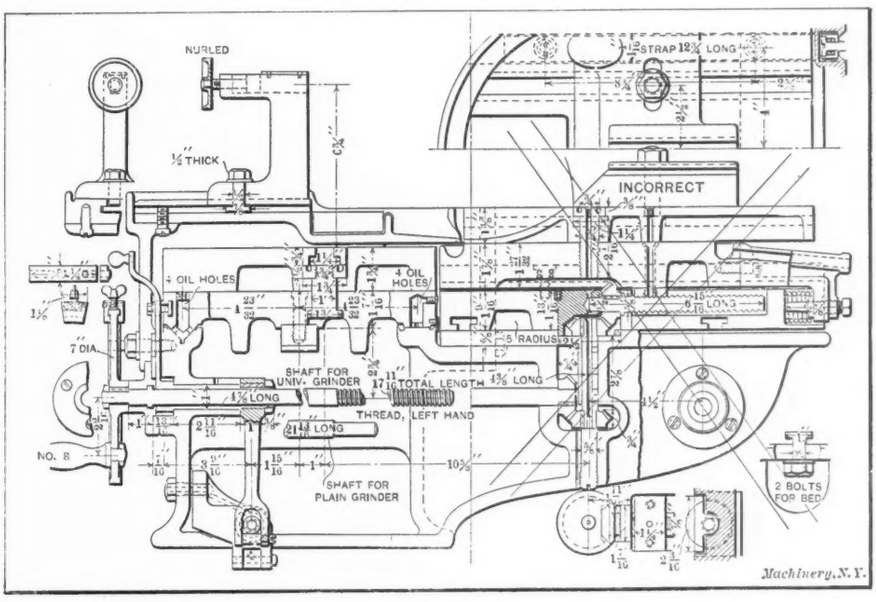


Fig. 10. Part of Drawing made in 1874 of Grinding Machine with Swiveling Wheel Stand

While the development of the grinder art since the Centennial Exposition has brought out many improvements and refinements, the essential principles of the universal grinding machine are found in the machines here described, and are as Mr. Brown left them at the time of his death in 1876.

MACHINE SHOP FLOORS

The question of what kind of floor to put into a new machine shop has become a rather vexing one of late, because the rising cost of lumber has made the wood floor an expensive matter, while the granolithic and other artificial surfaces that have come into use have often proved disappointing in wearing

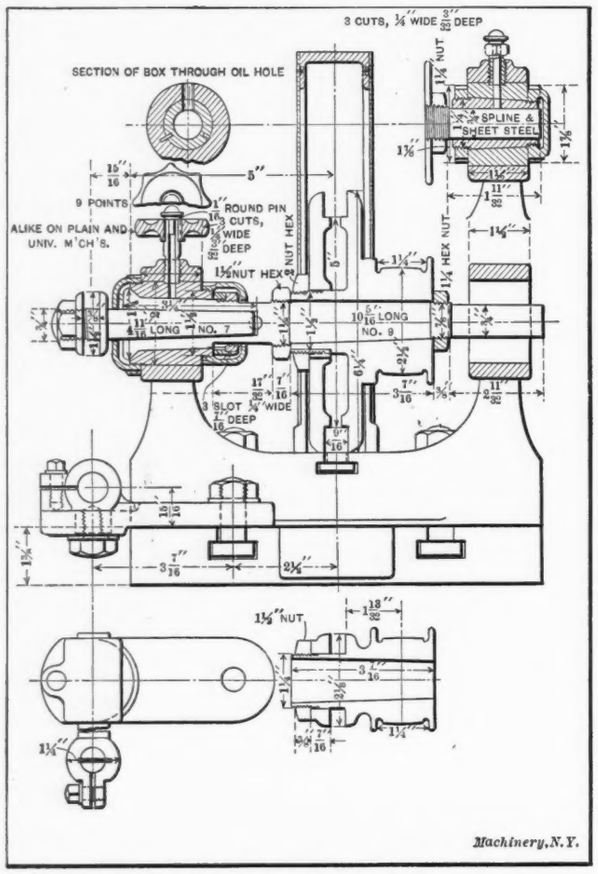

3 CUTS, 1/4" WIDE 3/8" DEEP
SECTION OF BOX THROUGH OIL HOLE
SPLINE & SHEET STEEL
9 POINTS ALIKE ON PLAIN AND UNIV. M'CH'S.
1" ROUND PIN
3 CUTS, 1/4" WIDE 3/8" DEEP
NUT HEX
1 1/4" HEX NUT
LONG NO. 7
LONG NO. 9
3 SLOT 1/4" WIDE 7/16" DEEP
1 1/8" NUT
Machinery, N.Y.

Fig. 11. Details of Wheel Stand of Grinding Machine designed in 1874

qualities, although at the same time they are cheaper than the wood floor. This whole question is thoroughly discussed in a pamphlet called "Wearing Surfaces for Factory Floors," in which the Aberthaw Construction Co., of Boston, reports the results of its investigation into the experience with different

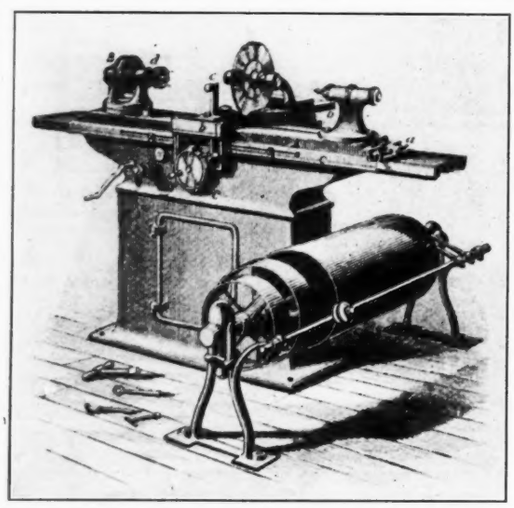


Fig. 12. The First Universal Grinding Machine, exhibited at the Centennial Exposition in 1876

floor surfaces of a large number of machine shops and factories.

Discussing the general principles of cost and construction of the two types of floor surface in fireproof buildings, the Aberthaw Co. says that the granolithic finish has the advantage in the points of first cost of the surface itself and in cost of the whole structure. It points out that the wood floor laid on

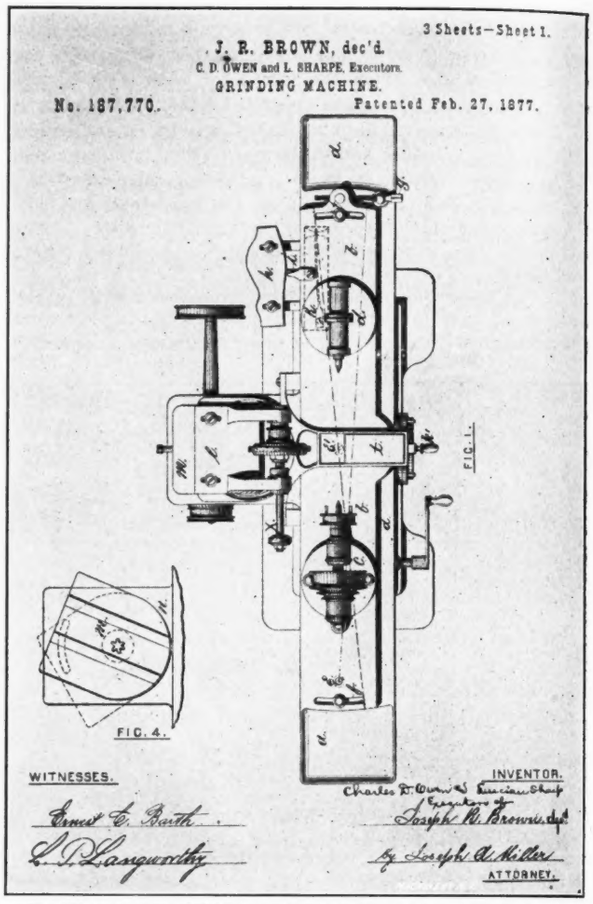


Fig. 13. Patent No. 187,770 granted to Estate of J. R. Brown for the Universal Grinding Machine

concrete floor slabs is a dead weight on the supporting structure, and necessitates an increase in thickness of floor slabs,

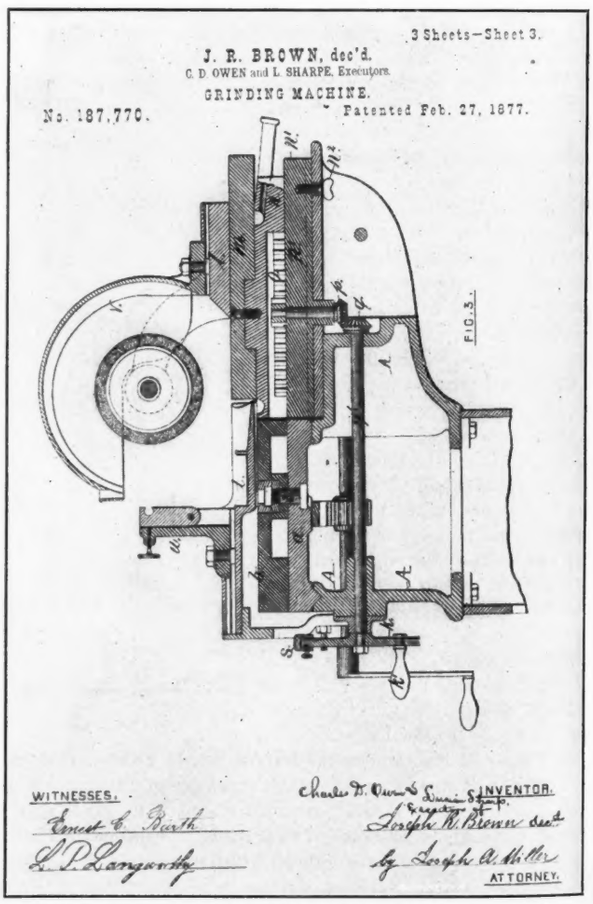


Fig. 14. Patent No. 187,770 granted to Estate of J. R. Brown for the Universal Grinding Machine

size and number of reinforcing members, and also of supporting pillars. In contrast, the granolithic finish, if it is laid as it should be before the concrete of the floor slab has become dry, forms an integral part of the floor slab and takes part of the compression strains. In other words, the granolithic finish laid on the green floor slab is not a dead weight like the wood floor, but is an actual strengthening of the floor slab. This means thinner slabs, lighter supports, and a general lower cost per cubic foot for the whole building.

In making its investigation the company put two questions to a large number of factories of various sorts; machine shops, engineers and architects in the northern and eastern part of the country, these questions being the following:

1. From your experience, do you believe that a granolithic or other masonry surface is actually bad for the operatives, and if so, why?
2. What objections do you know to granolithic finish that would make it advisable to incur greater expense for some other wearing surfaces?

Machine shops returned 68 per cent of the whole number of 118 replies. Of these machine shops, 27 per cent had had no experience with granolithic floors; 25 per cent recommended granolithic floors both in regard to the health of operatives and to the wearing qualities of the surface; 48 per cent offered more or less unfavorable criticism as to the wearing qualities or the effects on operatives from a granolithic surface.

The first question is disposed of in this report by the frank admission that where operatives have to stand still in one place on granolithic floor, they are likely to suffer somewhat from soreness of the feet and lameness of the legs, owing to the fact that concrete is a good conductor of heat and therefore chills the legs of operatives who stand still upon it. The two remedies suggested for this condition are: First, movable gratings of wood or other non-conducting material for workmen who have to stand still, as at a bench or lathe; second, the heating of concrete floors by running through the floor slab hot air ducts or steam pipes so that the floor slab shall be a radiating surface for the warming of the whole building. This system has been tried out with remarkable success in the plant of the Morse Chain Co., at Ithaca, N. Y.

In regard to the wearing qualities of granolithic floors, the company declares that the granolithic surface, if laid according to correct principles and with thoroughgoing, careful workmanship, will be free from dust and will give more and better service for general factory purposes than any other wearing surface. A set of specifications showing its own practice gives the details of what it considers correct theory and good workmanship. The granolithic surface, improperly constructed, the report says, is certain to fail—to be dusty, to crack abundantly, to chip under blows, and to wear away under trucking. A good deal of emphasis is put on the matter of wear by trucking. No masonry surface can long withstand the wear of heavy trucking when trucks are fitted with flat, sharp-edged, iron wheels. For such service a special design of steel plate embedded in the soft concrete, or the use of embedded racks made of small flat bars separated by thick washers and bolted together, are recommended.

The report is not, however, a partisan tract which attempts to give all credit to granolithic surface and none to others. On the contrary, it explicitly states that under many conditions the wood top floor is preferable to granolithic finish. One situation of this sort is that in which the conditions required for the construction of a perfect granolithic surface, cannot be obtained. If the granolithic surface cannot be made properly, it will be unsatisfactory, and it is better to lay a wood floor than to lay a defective granolithic surface. Some special manufacturing conditions also make the wood surface preferable even at higher cost, as for instance, when the manufactured product is very delicate and would be injured or destroyed if dropped upon a masonry surface. Several specifications are given in the report showing the practice of certain prominent engineers in the laying of wood top floors on cement base and on a tar concrete base.

* * *

Don't forget, when working around punch presses, that you need all your fingers, and that they will never grow out again; neither are there any more in stock.

THE DESIGN OF FLAT SPIRAL SPRINGS*

By L. J. BUTZOW†

The calculation and design of helical and elliptic springs has recently been treated in MACHINERY; but little has been published on the design of flat spiral springs. The following is an exposition of the principles entering into the calculation of this class of springs, and the most important equations have been deduced so that the reader who has little time for mathematics can obtain an idea of the subject and the use of these equations merely by studying the sample calculation given in the latter part of the article. The discussion on the energy of flat springs is applicable in particular to large springs which dissipate an appreciable portion of the stored energy through friction between consecutive convolutions.

In the following, let

r = radius of case, Fig. 1,
h = radius of hub, Fig. 1,
a = inside radius of unwound spring, Fig. 2,
b = outside radius of wound spring, Fig. 3,
t = thickness,
L = length,
T_u = number of turns in the unwound spring,
T_w = number of turns in the wound spring,
T = number of turns to wind spring,

The number of turns to wind the spring is equal to the difference between the number of turns in the wound spring and the number of turns in the unwound spring.

$$T = T_w - T_u \qquad (1)$$

From the figures it is seen that

$$T_w = \frac{b-h}{t} \text{ and } T_u = \frac{r-a}{t}$$

Substituting, we have

$$T = \frac{b-h-(r-a)}{t} \qquad (2)$$

From the figures it is also seen that

$$\pi r^2 = \pi a^2 + Lt, \text{ or } a = \sqrt{r^2 - \frac{Lt}{\pi}}$$

Also

$$\pi b^2 = \pi h^2 + Lt, \text{ or } b = \sqrt{h^2 + \frac{Lt}{\pi}}$$

Substituting for a and b in equation (2), we have,

$$T = \frac{1}{t}\left(\sqrt{r^2 - \frac{Lt}{\pi}} + \sqrt{h^2 + \frac{Lt}{\pi}} - r - h\right) \qquad (3)$$

which gives the number of turns which may be obtained from a spring of given thickness t and length L when placed in a case of radius r and wound on a hub of radius h.

The principal interest in equation (3) relates to the conditions which will give the maximum number of turns. By means of calculus we can find that T becomes a maximum when

$$\sqrt{r^2 - \frac{Lt}{\pi}} = \sqrt{h^2 + \frac{Lt}{\pi}} \qquad (4)$$

This equation, however, is simply $a = b$, and hence, the number of turns is greatest when the inside radius of the unwound spring is equal to the outside radius of the wound spring. The spring, in other words, should fill just half of the area provided.

Solving equation (4) for L, we have,

$$L = \frac{1}{2} \times \frac{\pi}{t}(r^2 - h^2) \qquad (5)$$

which gives the relation for best proportions.

Substituting for L in equation (3)

* For additional information relating to the design and calculation of springs, see MACHINERY, January, 1910, engineering edition: "The Design of Automobile Springs," and the articles there referred to. See also MACHINERY's Reference Series No. 58, "Helical and Elliptic Springs."

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$$T=\frac{1}{t}\left(\sqrt{r^2-\frac{1}{2}(r^2-h^2)}+\sqrt{h^2+\frac{1}{2}(r^2-h^2)}-(r+h)\right)$$

$$T=\frac{1}{t}\left(\sqrt{2\,(r^2+h^2)}-(r+h)\right) \qquad (6)$$

which gives the maximum number of turns available with a given case, hub, and thickness of spring.

The above formula, when correctly applied, gives reasonably

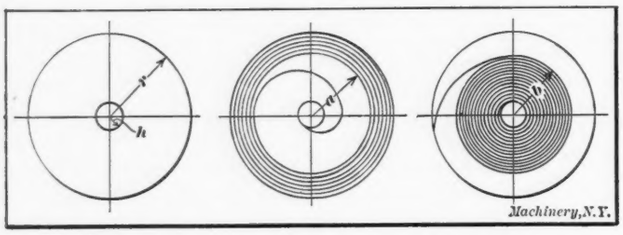

Fig. 1 Fig. 2 Fig. 3

accurate results. In the calculations, the thickness of the spring should be assumed to be a little greater than the micrometer measurement, to allow for the small spaces existing between adjacent coils. The radius h should be taken large enough not only for the hub, but also for the spring fastening. The radius r must be taken a little smaller than the radius of the case to make up for the connection of the spring at its outside end.

Relation between Torque and Number of Turns

The next step is to obtain the relation between torque and number of turns. A number of springs have been tested by measuring the torque developed at each turn of the hub throughout the process of winding and unwinding the spring. These data were then plotted and a smooth curve drawn through the points. A sample curve is shown in Fig. 4.

Logarithms of the abscissas and ordinates of a number of points were taken from the descending (lower) part of each curve, and plotted out as shown in Fig. 5. Straight lines were then drawn through the points. The inclination or angle of these lines is such that the tangent of the angle with the horizontal base line is 2/3. If this is assumed to be correct, the

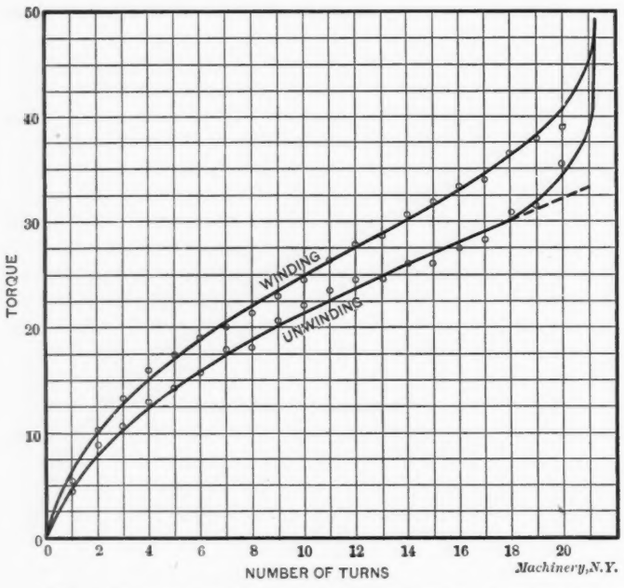

Fig. 4. Diagram showing Plotted Relation of Torque to Number of Turns in a Given Spring

torque, while unwinding, may be expressed by the product of a constant times the 2/3 power of the number of turns. The lines would probably agree more closely with the points if drawn at a somewhat smaller angle, but the lines as drawn provide for a simple mathematical expression and serve the purpose very well. A greater torque is required when winding the spring, due to the friction. When rapidly unwinding, a spring will not produce as great a torque as indicated by the diagrams, which merely show the torque that might be expected from the spring if it were stopped at any point while unwinding; but the diagrams and the equations in the following are of value for making comparisons.

The constant required depends upon the dimensions of the spring and the material and method of treatment. The effect of varying the thickness of the spring is to vary the torque at any given position by approximately the cube of the thickness, and to reduce the number of turns as shown by the formula already given. Varying the diameter of the hub and the length of the spring with small hubs and long springs principally affects the available number of turns. The relation between turns and length for a given hub and case is shown in Fig. 6.

In Merriman's "Mechanics of Materials" the following formula may be found:

$$\frac{S}{C}=\frac{E}{R}$$

where S = maximum fiber stress,
C = distance from neutral axis to remotest fibers,
R = radius of curvature,
E = coefficient of elasticity.

Then, for a spring tempered flat, it is evident that the part next to the hub will be subjected to the greatest stress. The

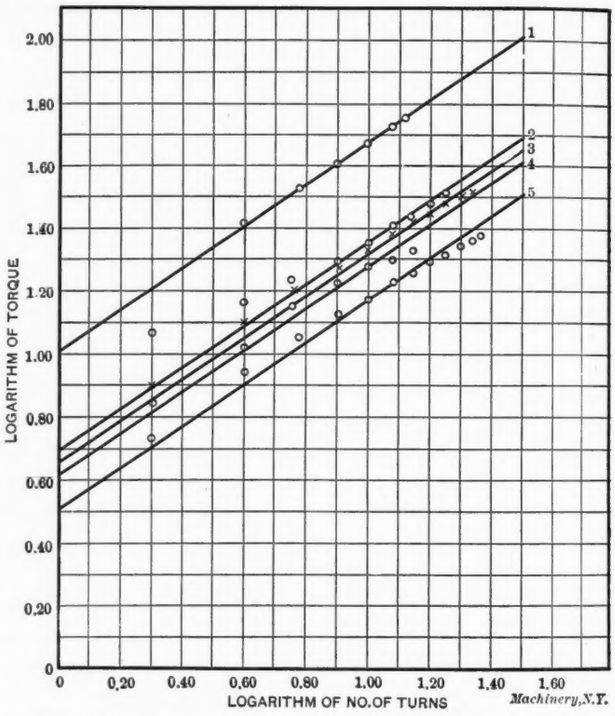

Fig. 5. Diagram showing Method of obtaining Formula giving Relation between Torque and Number of Turns

radius of curvature at any given point on the spring very closely approximates its distance d from the center of the hub. Then the above formula may be written

$$\frac{S}{C}=\frac{E}{d}$$

This gives a method for finding the radius of the hub. This radius should not be so small as to cause the fiber stress to pass beyond the elastic limit except when necessary to meet commercial conditions. In many cases, where the space is limited, it would be advantageous to temper the entire spring, or at least the inside end of it, on a psiral curve, and in that way allow for a small hub and still keep the stress within working limits. If the entire spring is formed to a curve when tempered, it should be so proportioned as to give a constant uniform stress throughout the spring when fully wound. It is evident, however, that this would materially increase the cost of production.

Assume $P = KT^{\frac{2}{3}}$, where P = torque, and K = constant.

Let E = energy in foot-pounds. Then by the methods of calculus

$$E = \frac{6\pi K T^{\frac{5}{3}}}{5}$$

which gives the relation between number of turns and available energy at slow speed for a given spring. This energy is equal to a constant times the cube root of the fifth power of the number of turns.

The amount of energy which may be stored in a given spring is approximately proportional to its weight, and is equal to about 60 foot-pounds per pound of spring. A relatively thick spring of few turns will store no more energy than a thin spring of many turns, provided the weights are equal. On account of this it is also evident that the torque may be increased without changing the number of turns, by merely increasing the width of the spring. If the torque is sufficient, but a greater number of turns is required, the spring should be lengthened. Should it be found that a smaller torque with a given number of turns, or fewer turns with the given torque is sufficient, then material may be saved by reducing the weight of the spring even if the same case is used. When it is found that the capacity of the spring is adequate but that its torque and turns are not correctly proportioned, the difficulty may be adjusted by varying the length and cross-section, keeping the weight constant.

As a practical example suppose that a maximum available torque of 50 pounds is required from a spring having 30 turns. Assume that the spring is tempered flat.

$$\text{Torque} = KT^{\frac{2}{3}}$$

$$50 = K\,30^{\frac{2}{3}} = K \times \sqrt[3]{30^2} = K \times 9.65$$

$$K = \frac{50}{9.65} = 5.2$$

$$\text{Energy} = \frac{6\pi K T^{\frac{5}{3}}}{5} = \frac{6\pi \times 5.2 \times \sqrt[3]{30^5}}{5} = 5680 \text{ foot-pounds}$$

Assume 60 foot-pounds per pound of spring. Then,

$$\text{Weight} = \frac{5680}{60} = 95 \text{ pounds.}$$

Assume radius of hub = 3 inches, maximum stress = 200,000 pounds, and E = 30,000,000. Then

$$\frac{S}{C} = \frac{E}{R},$$

$$C = \frac{3 \times 200{,}000}{30{,}000{,}000} = 0.02$$

$$t = 0.04$$

Allow 0.042 thickness, for non-uniformity of spring.

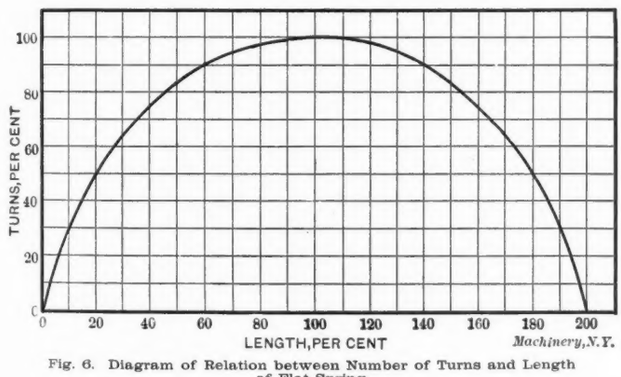

Fig. 6. Diagram of Relation between Number of Turns and Length of Flat Spring

From formula (6) we have, when $T = 30$, and $t = 0.042$:

$$30 = \frac{1}{0.042}\left[\sqrt{2\,(r^2 + 3^2)} - (r + 3)\right]$$

$r = 8.54$ inches, or diameter = 17.08, or about 17⅛ inches.

From formula (5)

$$L = \frac{1}{2} \times \frac{\pi}{0.042}\,(8.54^2 - 3^2) = 2391 \text{ inches, or 200 feet,}$$

nearly.

$$\text{Width} = \frac{95}{0.283 \times 2391 \times 0.040} = 3.5 \text{ inches, about.}$$

Hence, size of spring equals 0.04 inch × 3½ inch × 200 feet; inside diameter of case inside of spring fastening, 17⅛ inches; diameter of hub outside of spring fastening, 6 inches.

General Remarks

Springs as large as the one just calculated are used in spring motors. These motors may be built in several ways. When the external diameter is limited, a good method is to

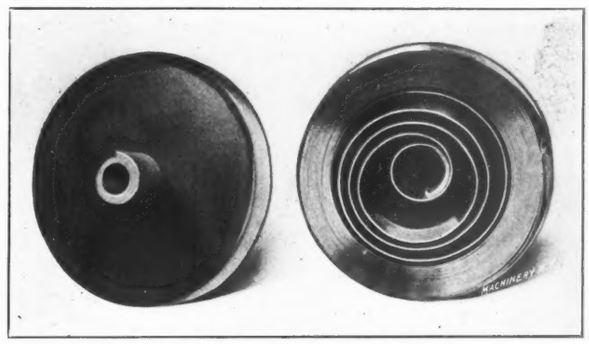

Fig. 7. Method of Arranging Springs "in Series" where the Space is Limited

make the spring in sections and to place these sections on a shaft so that they may be fastened together. This may be done by providing the inside end of each sectional spring with a clip as shown in Fig. 7, which fits into a notch in the hub of the next case. Then all of the springs may be wound together and all will unwind together. The torque produced equals the torque of one spring, but the number of turns equals the sum of the number of turns of the individual springs. One of the advantages of this method is that if one spring breaks, it can be replaced at a lower cost than could a large spring that took the place of all the individual springs. The calculations previously given may be applied to this construction as well, by assuming that each sectional spring stores its relative portion of the required energy.

* * *

SAFETY OF TRAVEL ON THE PENNSYLVANIA SYSTEM

Figures recently compiled by the Pennsylvania Railroad and its subsidiary lines show that in 1908 and 1909 a total of 299,762,658 passengers were carried on its 24,000 miles of track, and only one passenger out of this number was killed as a result of a train wreck. This is an extremely good record, and credit should be given to the management of the railway system to whose efforts in regard to car equipment, signaling systems, discipline and training of employes this result is due. If the same results were duplicated on other American railways there would be only about three passengers (instead of between three and four hundred) killed in train accidents yearly in the whole of the United States. During the same two years 370 passengers were injured in train wrecks. This is also a low figure compared with the total for the railways in the United States. In fact, the number of passengers injured in proportion to the number of passengers carried on the Pennsylvania lines is only about one-eighth of the average number injured on all the railways in the United States. This record of the Pennsylvania Railroad is all the more remarkable as its traffic is heavier than that of any other railroad in the country, which means that it operates more trains than any other railroad and hence would meet with more opportunities for accidents. The number of passenger collisions was two less and the number of freight collisions 15 less in 1909 than in 1908, while the number of freight derailments was 69 less in 1909.

As compared with the records abroad, the Pennsylvania Railroad holds a better record, even, as regards the small number of passengers killed than the German state railroad system, noted for its safety. As regards the number of passengers injured, however, several of the European systems are still ahead of the Pennsylvania Railroad.

SHOP HEATING BY DIRECT RADIATION*

By CHAS. L. HUBBARD†

While it is probably true that a large proportion of the shops and foundries erected at the present time are equipped with hot-blast heating, there are still many cases where for various reasons the older form of heating by direct radiation seems preferable to the owners, and to these a few practical points in regard to the proper methods of installing and operating a system of this kind may be of considerable value. For example, a shop may be heated by a system of direct radiation, which originally gave satisfaction, but which, owing to numerous changes and extensions, fails to operate properly. The owner may feel that it is necessary to install an entirely new system of heating, when perhaps a few changes or additions may make the old one as good as new. Again, an addition to the plant may be in progress and it is

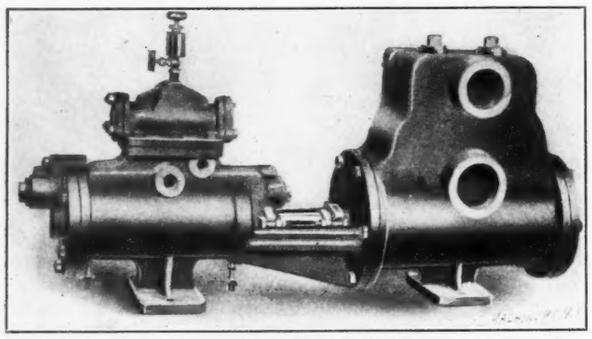

Fig. 1. Special Vacuum Pump for obtaining Necessary Suction in an Overloaded System

desired to extend the present system of direct heating rather than install a hot-blast apparatus in a single building. The object of this article is to give some of the faults of direct heating as commonly found in shops and factories, together with suggestions for overcoming them entirely or in part. Rules to be observed in laying out and installing new work will also be given, as well as a review of correct methods of extending present systems to include new buildings or additions to old ones. Some of the points to be considered in connecting a heating system with a power plant will also be touched upon.

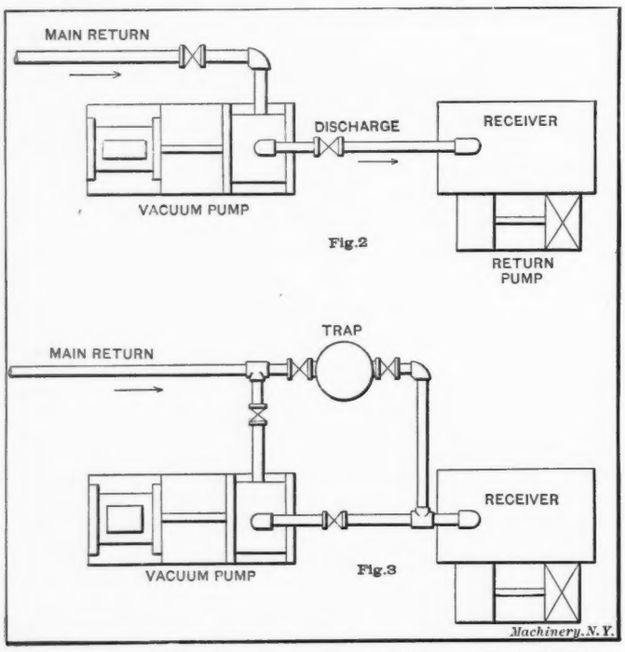

Fig. 2. Method of Connecting Vacuum Pump, used continually, to the Return. Fig. 3. Method of Connecting Vacuum Pump, when used only at intervals, to the Return

Faults of Direct Heating Systems

Among the most common causes of trouble in existing plants which have been changed and enlarged from time to time are small pipes, insufficient grading, and air binding. The system may have worked satisfactorily in the beginning, when doing only the work for which it was designed, but numerous additions have so overloaded the supply mains and branches that the pressure is considerably reduced in the more remote parts of the system. In addition to this, the returns are flooded by the increased amount of condensation, and the result is poor circulation of steam, cold pipes, and water-hammer.

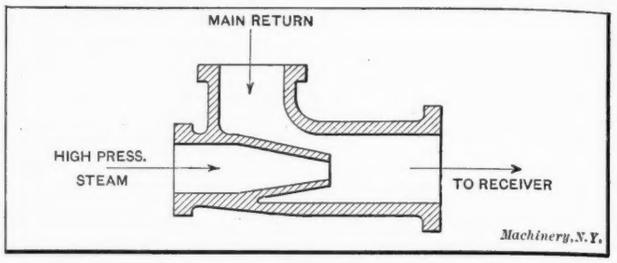

Fig. 4. Steam Ejector used for Cleaning the Pipes and Starting up the Circulation

Matters are made worse from the fact that there are usually no basements in which to carry sealed or wet returns; hence it is necessary to rely on drainage through dry returns, which are much more likely to give trouble than when the mains are sealed. Both supply pipes and overhead returns in extended systems are likely in time to sag and form pockets for the accumulation of condensation. This results in the holding back of air in certain parts of the piping and coils, and causes poor circulation and water-hammer.

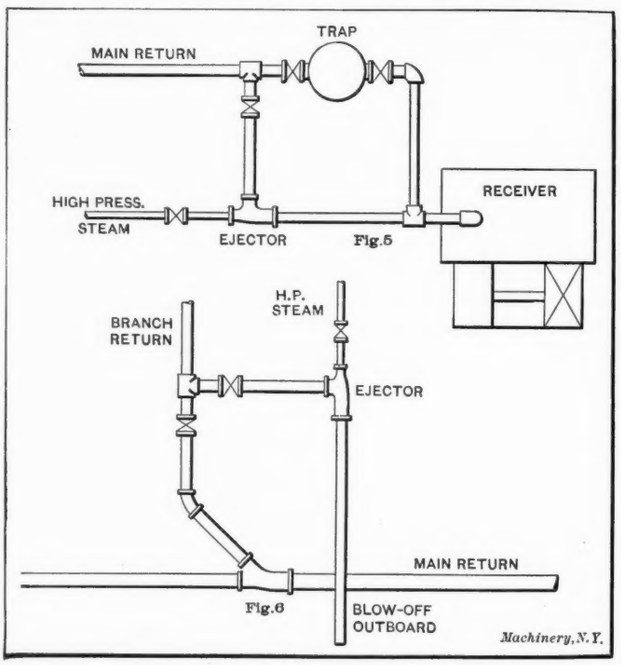

Fig. 5. Method of Connecting the Ejector with the Return Main. Fig. 6. Ejector connected with a Branch having Defective Circulation

About the only way to deal with a situation of this kind is to first re-grade the piping wherever it is found necessary to give the required pitch in the right direction, and then attach some form of suction to the end of the main return. If the system of piping is quite extensive and in bad condition, it may be best to place the matter in the hands of some engineering concern making a specialty of vacuum systems for the return of condensation. There are many cases, however, where the necessary results can be secured by home-made methods, or by means within the reach of any good steam fitter.

The necessary suction is best obtained by attaching a special vacuum pump to the main return. Pumps for this particular purpose can be obtained from the best manufacturers, and one of well-known make is shown in Fig. 1. The condensation from heating systems of this kind is usually trapped

* For further information on this and kindred subjects, see MACHINERY, November, 1909: "Heating and Ventilating Offices in Shops and Factories," and previous articles there referred to.

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into a vented receiver, from which it is automatically pumped back to the boilers. In attaching a vacuum pump to the return, the connections may be made as shown in Fig. 2, when it is intended to use the pump all the time, or as shown in Fig. 3, when it is desired to retain the trap and use the pump simply for clearing the system of air in the morning when first warming up, or at intervals during the day when the circulation becomes sluggish. There are many cases where the system will work satisfactorily after the pipes and coils are once cleared of air, and steam circulation established. Operating the vacuum pump for a short time in the morning is often all that is necessary.

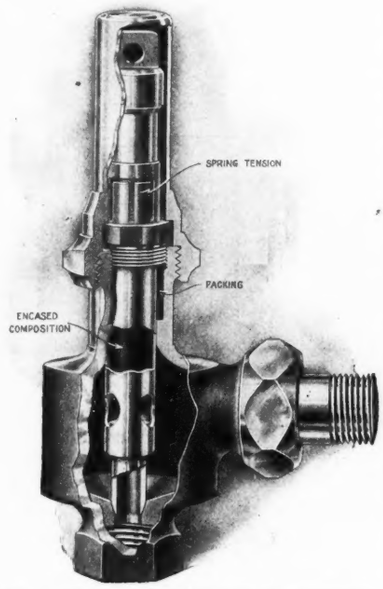


Fig. 7. Thermostatic Valve used in Connection with a Vacuum Pump

Sometimes an ordinary steam ejector connected into the return is all that is necessary to clear the pipes and start up the circulation. Such a device is shown in Fig 4, and the method of connecting it into the return main, in Fig. 5. Sometimes defective circulation may be confined to one particular building or section of the heating plant. In this case all that is necessary may be to connect an ejector into this particular branch, and exhaust the air and water once or twice a day as may be required. If this branch connects with the main return at some distance from the receiving tank, the exhaust may be blown outboard, as it will be operated only for a short time and the waste will be small. Connections for the arrangement above described are shown in Fig. 6. Whenever ejectors are used in this way it is necessary to have steam at a higher pressure for operating them.

The principal feature in the patented vacuum systems is the automatic valve placed at the return end of the coil or radiator which opens only to allow the passage of air and water, and closes in the presence of steam. If the ordinary radiator valve is used and left wide open, there will be short-circuiting through the nearer coils and radiators, while very little, if any, vacuum will be formed in the returns and coils more remote from the pump.

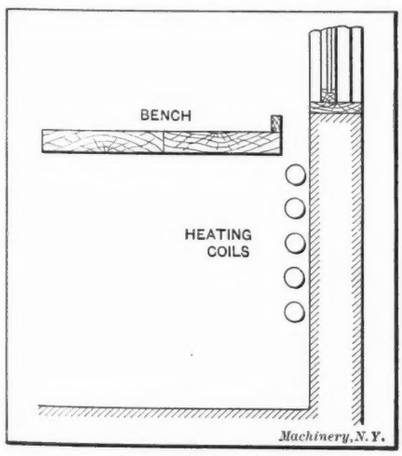


Fig. 8. A Good Method of Placing the Heating Coils

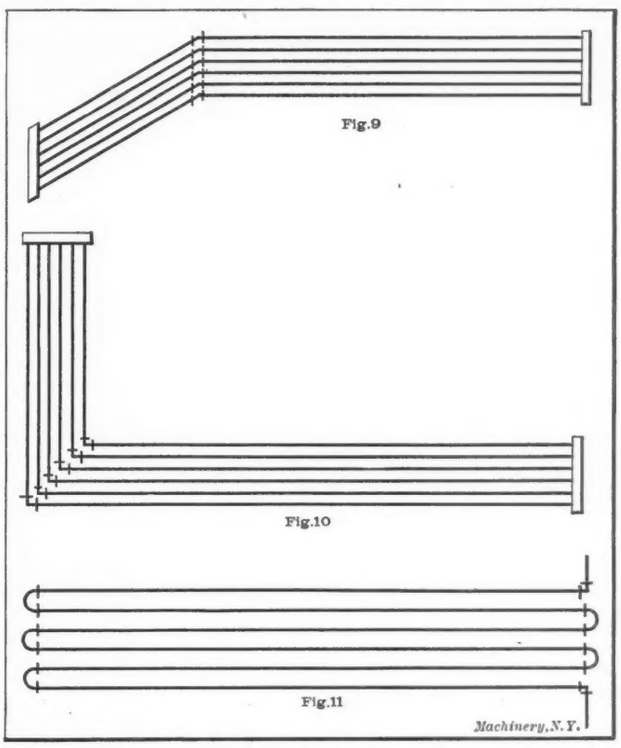
When the plant is not too large very good results may be obtained by throttling the return valves, leaving an opening just sufficient to care for the condensation under the slight vacuum formed in the returns. When this is done, the radiators and coils should be inspected at frequent intervals to make sure that the throttled valves do not become clogged. If this occurs, they should be opened wide and the steam and water allowed to blow through for a short time, which will usually serve to clear them. Sometimes it is not necessary to throttle the valve on each coil and radiator, but they can be grouped together and a throttle valve placed in the branch return from each group. Special thermostatic traps or valves are now on the market which can be used on the return end of the radiators and coils in connection with a vacuum pump if so desired, such a trap being shown in Fig. 7. These open automatically to allow the passage of air and water from the coil.

Throttling and automatic return valves must only be used when the vacuum pump is to be operated continuously, as otherwise the coils would not drain properly when returning by gravity without a vacuum.

There are several types of patented vacuum systems in use, some operating by exhausting the air from the radiators through special air-valves, while the condensation flows to the receiving tank by gravity in the usual manner. In others the vacuum is attached to the return main in a manner similar to the method already described, no air valves being used. The latter arrangement is preferable for the class of buildings under consideration, as it overcomes the effect of improper grading of the return pipes to a considerable extent, and also makes it possible to work with less distance between the heating coils and the return mains.

Design of a New System

Let us next take up some of the points to be considered in the design of a new system. We will assume that it is to operate by gravity without the use of a vacuum pump, it being a simple matter to add this accessory should the plant outgrow the gravity method for the return of condensation. The first step in the design of a new system is to compute the amount of heating surface. For ordinary conditions, with low-pressure steam, there should be about one square foot of heating surface for each 10 square feet of wall surface, and the same amount for each 4 square feet of glass surface. If the building is in an especially exposed location or not especially well built, use the constants 8 and 3 in place of 10 and 4. For one-story buildings and upper floors having an exposed roof surface without attic space beneath it, count the roof the same as wall. The square feet of heating surface can be reduced to linear feet of pipe by the following:



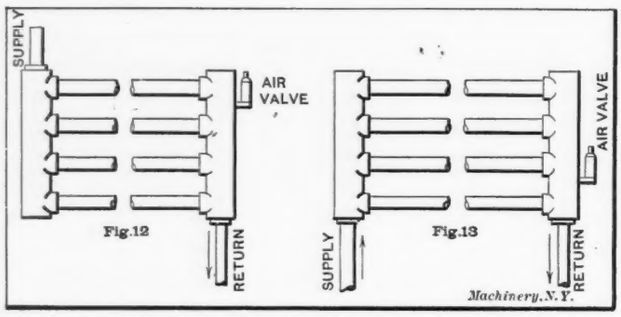
Figs. 9, 10 and 11. Branch Coil, Miter Coil and Return Bend or Trombone Coil

TABLE I

Square feet of surface multiplied by		Linear feet of
3	=	1- inch pipe
2.3	=	1¼-inch pipe
2	=	1½-inch pipe

The next point to be considered is the form and location of the radiating surface. For shops and similar rooms, circulation coils of 1¼-inch pipe are most commonly used. These are best placed along the walls beneath the windows, but if for any reason this cannot be done, they may be suspended on the side at a height of 8 or 9 feet above the floor. This height, again, is governed to some extent by the position of shafting, cranes, etc., and must be located to suit the actual conditions in each particular case. An ideal way to place the coils, from a heating standpoint, is shown in Fig. 8. By setting the bench out about 3 inches from the wall the warm air from the coil rises in front of the windows where it is most needed.

If there is no basement in which to carry the return pipes, there is sometimes difficulty in using this arrangement, for if they are carried above the floor it is likely to bring them too close to the bottom of the coils. If the supply pipes are of good size so as to keep up the pressure, the return may run within 18 inches of the lowest pipe of the coil; but for ordinary conditions 24 inches is better. If the vacuum system is used, the return may be carried much closer to the coil. Sometimes sufficient space may be obtained by carrying the return in a trench. In other cases there may be enough room to carry the returns beneath the floor; but in case this is done, they should be thoroughly protected against freezing.



Figs. 12 and 13. Supply and Return Ends of Branch Coil with Different Methods of Steam Supply, and Corresponding Positions of Air Valve

Common forms of heating coils are shown in Figs. 9, 10, and 11. The coil in Fig. 9, called a branch coil, is shown in perspective and is used wherever there is a chance to carry it around a corner in order to secure flexibility. The miter coil shown in Fig. 10 is used in places where a doorway or other obstruction prevents the use of a branch coil, and where there is space on the wall for carrying up a vertical portion to care for expansion. Overhead coils are usually of the miter form, laid on the side and supported by means of pipe-rolls and hangers. The wall coils are supported on hook-plates made especially for the purpose. Fig. 11 shows a "return bend" or "trombone" coil, which is used where there is no opportunity for breaking the coil around a corner or carrying it up the wall as in Fig. 10.

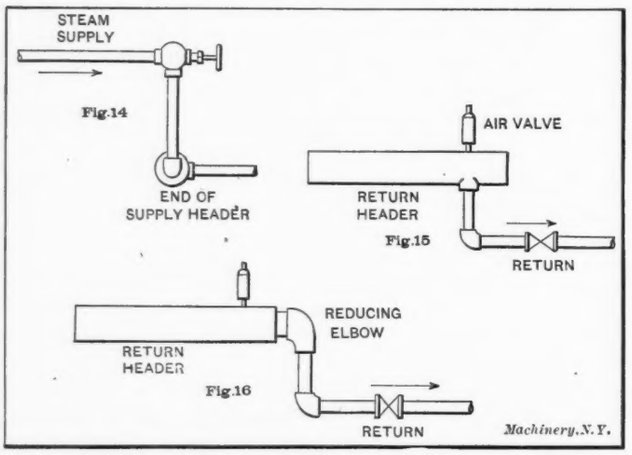


Fig. 14. Method of Making Connection with an Overhead Coil. Fig. 15. Method of Connecting Return Main to Coils. Fig. 16. Using an End Connection between Return Header and Return Main

In making the steam and return connections to coils, care should be taken to arrange them in such a way as to obtain the necessary air venting and drainage. Figs. 12 and 13 show the supply and return ends of a branch coil with different methods of steam supply and the corresponding position of the air valve. Fig. 12 shows the more common way of supplying steam to the top of the header. In this case the steam has a tendency to be driven past the upper pipes of the coil and to flow through the lower ones first. This forces the air to the upper part of the return header, at which point the air valve should be located as indicated in the illustration. Sometimes, on the upper floors, it is more convenient to connect the supply into the bottom of the header as in Fig. 13. In this case the conditions are reversed and the air valve should be placed near the bottom of the return header instead of at the top.

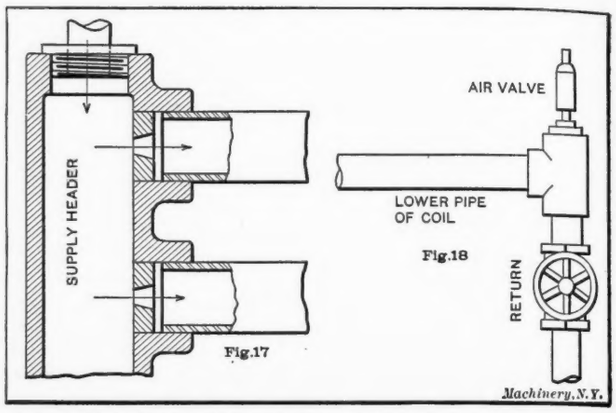


Fig. 17. Method of Equalizing the Flow of Steam from the Header to the Different Pipes in the Coil. Fig. 18. Method of Attaching Air Valve to Trombone Coil

Fig. 14 shows the method of making the connections with an overhead coil. When possible, it is best to use what is known as a "side-outlet" branch-T for the return header, as this, when in position, makes it possible to connect the return pipe into the bottom of the header, thus securing better drainage. The return mains and branches should always be carried at a lower level than the coils, as shown in Fig. 15. Sometimes it is not possible to obtain the side-outlet headers when wanted. In this case an end connection may be used, provided a reducing elbow is employed, taking in the full size of the opening at the end of the header as shown in Fig. 16. The opening in the return header should never be bushed when used in this way. In placing the air valve, it is better to tap into the top of the header, as shown in Fig. 12, rather than to connect it into the plug in the end of the header as is sometimes done. With the former connection there is less liability of its becoming filled with water and dripping.

TABLE II

Square Feet of Radiation	Size of Steam Pipe	Size of Dry Return	Size of Sealed Return
60	1	¾	¾
100	1¼	1	¾
130	1½	1	1
350	2	1¼	1
650	2½	1¼	1
1000	3	1½	1¼
1600	3½	2	1½
2200	4	2½	2
4000	5	3	2
6000	6	3	2½

One difficulty commonly experienced with circulation coils is that the steam, when first turned on, is quite likely to flow through certain pipes first, filling the return header, and then entering the remaining pipes at the return end, thus pocketing a considerable quantity of air in the center of the coil and causing it to remain cold. This condition can be avoided to a considerable extent by inserting a bushing with a small opening, about ¼ inch in diameter, in each pipe opening at the supply end as shown in Fig. 17. This equalizes the

flow of steam to the different pipes and causes the whole coil to fill evenly from the supply end. Fig. 18 shows a good way of attaching the air valve and making the return connection for a trombone coil. In this case the steam flows through each pipe of the coil in series, so there is no danger of air pocketing unless steam enters the return end from some other coil.

The sizes of supply and return pipes may be taken from Table II, which may be used for lengths of run up to 200 or

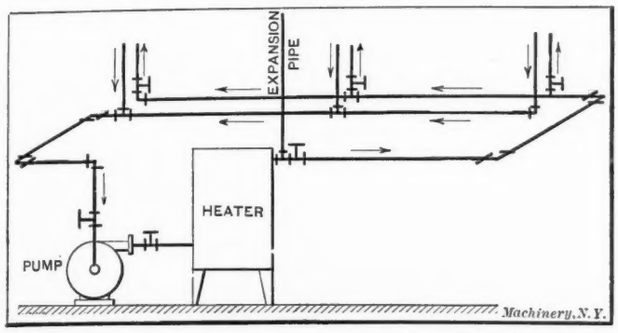


Fig. 19. Two-pipe System for Forced-circulation Hot-water Heating

250 feet; for greater lengths the pipes should be increased a size or more according to conditions.

Thus far only steam heating has been considered. When there is plenty of exhaust from the engines so that the matter of steam economy does not have to be considered, this method of heating is very satisfactory and has its strong points. The principal fault with direct steam is the difficulty in regulating the temperature of the rooms, and this usually results in a considerable waste of heat through open

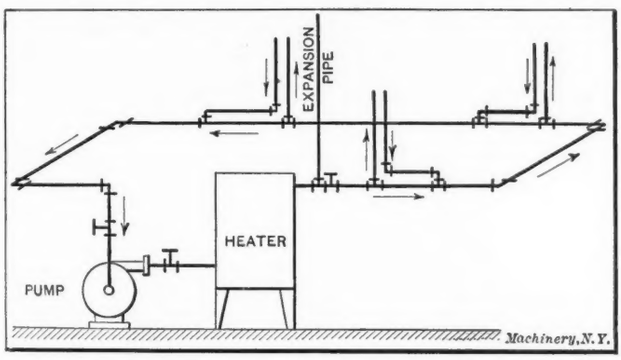


Fig. 20. Single Pipe or Circuit System for Forced-circulation Hot-water Heating

windows in mild weather. It is true that the temperature can be regulated by shutting off and turning on the heating coils, but the chances are that the workmen will resort to the easier method of opening windows. This has its advantage in providing a certain amount of fresh air, but ventilation by means of open windows in cold weather is not always desirable. If a vacuum system is used, a considerable range in temperature can be obtained by using a vacuum reducing valve which allows steam pressures below the atmosphere to be carried in the heating system.

When considerable live steam is necessary for heating, and it is desired to economize in its use, very satisfactory results may be obtained by the use of hot water under forced circulation. In this way the entire heating system is under the control of the engineer who can vary the temperature of the water to suit the requirements at all times. Under these conditions of warming very little heat will be lost through open windows. The piping need be no more complicated nor the heating surface more extended than in the case of low-pressure steam heating. By placing the expansion tank at a sufficiently high elevation, and using a small amount of live steam, the temperature of the water may be made to equal that of low-pressure steam in the coldest weather.

The mains for forced circulation are usually carried in one of two ways. In the two-pipe system shown in Fig. 19 the supply and return are carried side by side, the former reducing in size and the latter increasing as the branches are taken off. The flow through the coils is produced by the difference in pressure in the supply and return mains. As this is greatest nearest the pump, it is necessary to place throttle valves in the branches to equalize the flow to the different parts of the system.

The single pipe or circuit system is shown in Fig. 20. In this case a single main is carried entirely around the building, the ends being connected with the suction and discharge of the pump, as shown.

The supply risers are taken from the top of the main and the returns connected into the side, a short distance along the line. Circulation through the risers and coils is due partly to gravity (the hotter water rising from the top of the main to the coil and the cooler return-water falling through the return pipe) and partly to the drop in pressure in the main between the points at which the supply and return pipes are connected. When there is a basement in which the circuit main may be carried, this system of piping is the simp-

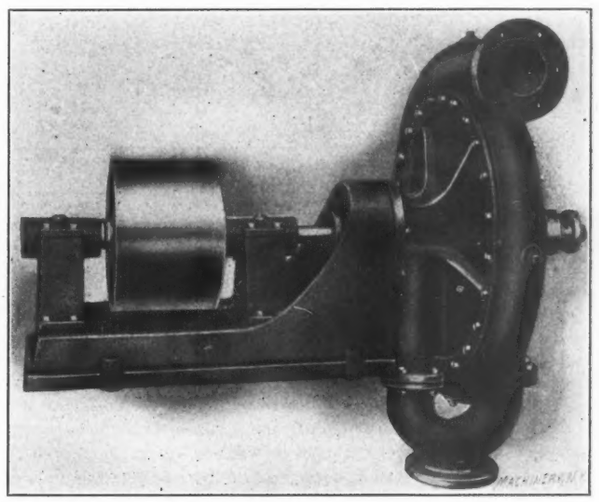


Fig. 21. Belt-driven Centrifugal Pump for Heating Service

ler, but the two-pipe system has the advantage of a decided drop in pressure between the supply and return mains, so there is much greater flexibility in running the pipes, which makes it much better adapted to the conditions found in shop heating. Both supply and return mains may, for example, be carried at the ceiling, or both at the floor, or one at the ceiling and the other at the floor. A good arrangement for a two-story building is to carry both mains at the ceiling of

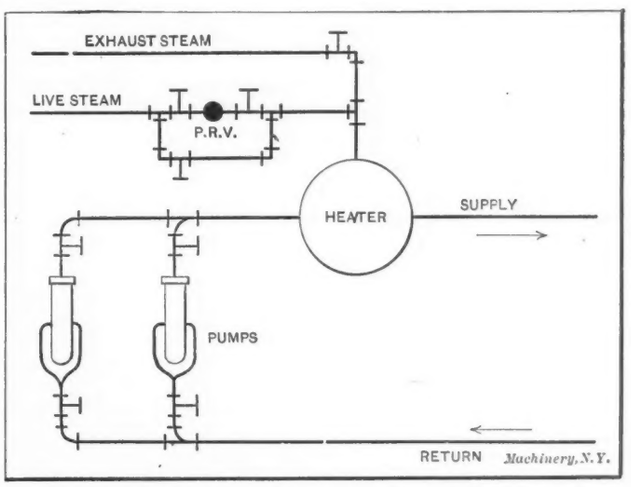


Fig. 22. Diagram of Connections between Pump and Heater when Live and Exhaust Steam are used in the same Heater

the first story, and connect with the first floor coils by drops and with the second floor by risers. In a one-story building both mains are usually carried overhead, as they are less in the way of machinery and other equipment.

In the circuit system it is customary to count on a drop in pressure of about 20 degrees between the pump suction and discharge, and in the two-pipe system to allow a drop of

about 40 degrees. In the circuit system the return water from the radiators flows back into the main, so the supply to the radiators along the line becomes cooler and cooler as the distance from the pump increases. For this reason, a larger volume of water must be circulated at a less drop in temperature, or the size of the heating coils and radiators must be increased along the line to make up for an excessive drop in temperature of the circulating water. Hence, it is a choice between a larger pump and main, or more radiating surface. In the two-pipe system all of the radiation is supplied with water at practically the same temperature, except for the slight cooling which results from radiation from the main

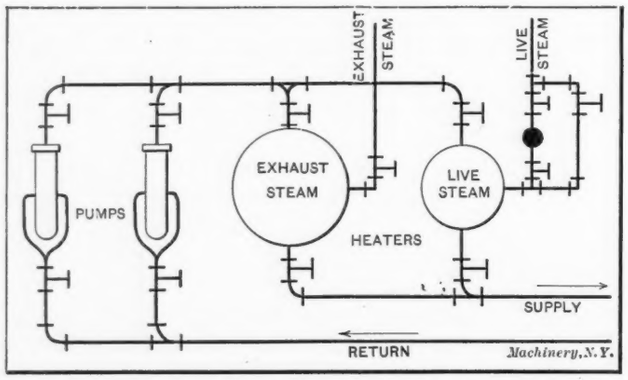
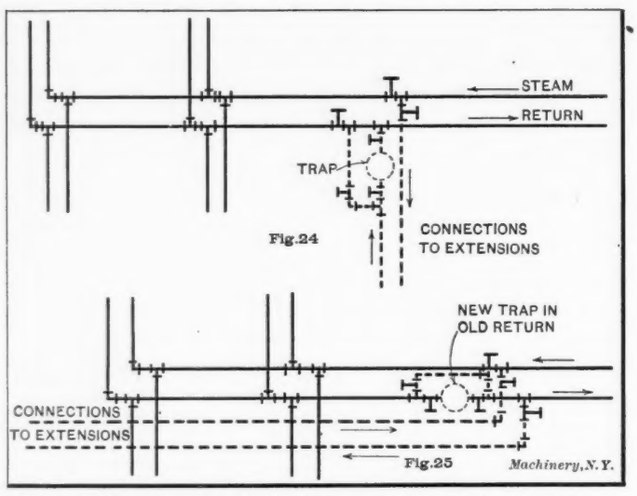


Fig. 23. Diagram of Connections between Pump and Heater when Separate Heaters, in Parallel, are used for Live and Exhaust Steam

itself. The size of mains and capacity of pump depends upon the volume of water circulated, and this, in turn, upon the amount of radiating surface and the drop in temperature of the circulating water.

Example of Calculations

Taking the case of a circuit main, and allowing a drop in temperature of 20 degrees, there will be $8.3 \times 20 = 166$ heat units given up to the heating system by each gallon of water circulated. If the water is pumped into the system at a temperature of 200 degrees and cooled to 180, the heating coils will have an efficiency of about 220 heat units per square foot of surface per hour. Hence there should be $220 \div 166 =$ 1.33 gallons of water circulated per hour for each square foot of radiation, or $\frac{1.33 \times 100}{60} = 2.2$ gallons per minute for each 100 square feet of radiation. Assuming approximate velocities of flow of 3.4 feet per second for pipes 3 inches in diam-



Figs. 24 and 25. Methods of Making Connections for Additions located near the Boiler-room and at the Extreme End of the Line

eter and under, 5.0 feet for 4-inch pipes, 5.7 feet for 5- and 6-inch pipes, and 8.0 feet for 7- and 8-inch pipes, we have in Table III the pipe sizes for various amounts of radiating surface. These sizes are suitable for mains up to 1500 feet in length, or even 2000 feet in special cases, if necessary.

The mains in the two-pipe system may be made somewhat smaller, owing to the greater drop in temperature allowed. On the other hand, the radiation will be slightly less efficient, owing to the lower average temperature of the water. Proceeding as before, and allowing a drop in temperature from 200 to 160 degrees, we have $8.3 \times 40 = 332$ heat units given up by each gallon of water circulated. Assuming in this case

TABLE III

Size of Circuit Main, Inches	Square feet of Direct Radiation Supplied
3	3,400
4	9,000
5	16,000
6	22,000
7	43,000
8	56,000

TABLE IV

Size of Mains for Two-pipe System, Inches	Square Feet of Direct Radiation Supplied
3	7,000
4	18,000
5	32,000
6	44,000

an efficiency of 210 heat units for the radiation, we have

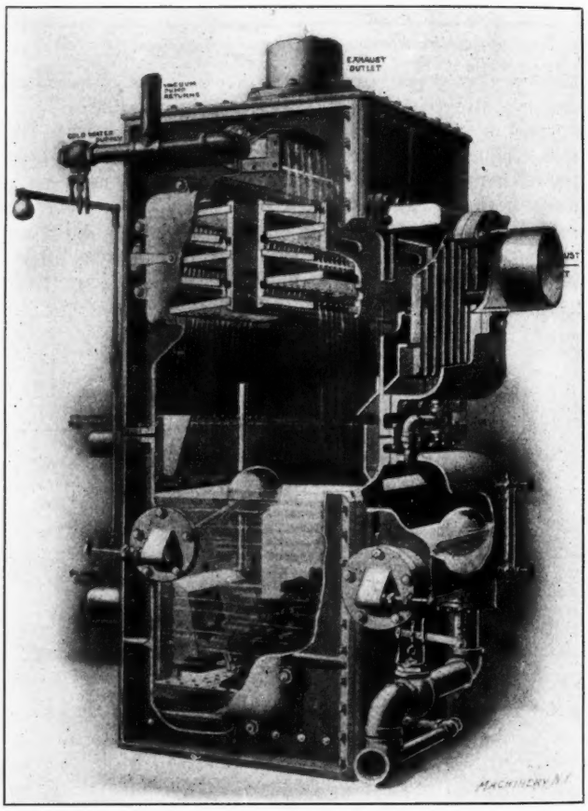


Fig. 26. Open Heater Combining Oil Separator, Feed Water Heater, Purifier, Return Tank and Filter

$210 \div 332 = 0.63$ gallon of water required per hour for each square foot of radiation, or $\frac{0.63 \times 100}{60} = 1.05$ gallon per minute for each 100 square feet of radiation. Using the same velocities as before we have in Table IV the sizes of pipe mains for the two-pipe system. These sizes are also for circuits up to 1500 to 2000 feet in length. Should it be decided to use a drop in temperature of 30 degrees instead of 40, the amount of surface supplied by any given size of pipe would be the mean of the quantities given in Tables III and IV.

The branches and risers to the coils are made considerably larger than the mains in proportion to the volume of water

TABLE V. SIZES OF RISERS AND COIL CONNECTIONS FOR THE SINGLE-MAIN OR CIRCUIT SYSTEM

Size of Pipe, Inches	Square Feet of Radiation
¾	20
1	40
1¼	70
1½	120
2	250
2½	300

TABLE VI. SIZES OF RISERS AND COIL CONNECTIONS FOR THE TWO-PIPE SYSTEM

Size of Pipe, Inches	Square Feet of Radiation
¾	40
1	80
1¼	150
1½	250
2	500
2½	600

which they carry. The pipe sizes in Tables V and VI may be used for the circuit and two-pipe systems, respectively.

Pumps

Pumps of the centrifugal type are best adapted to this class of work on account of their simplicity and the low-pressure heads required. For the sizes of pipe given in Tables III and IV the required pressure head for overcoming the friction in the mains will not exceed 40 feet for straight lengths of pipe up to 1500 feet. Each long-turn L and T adds 4 and 9

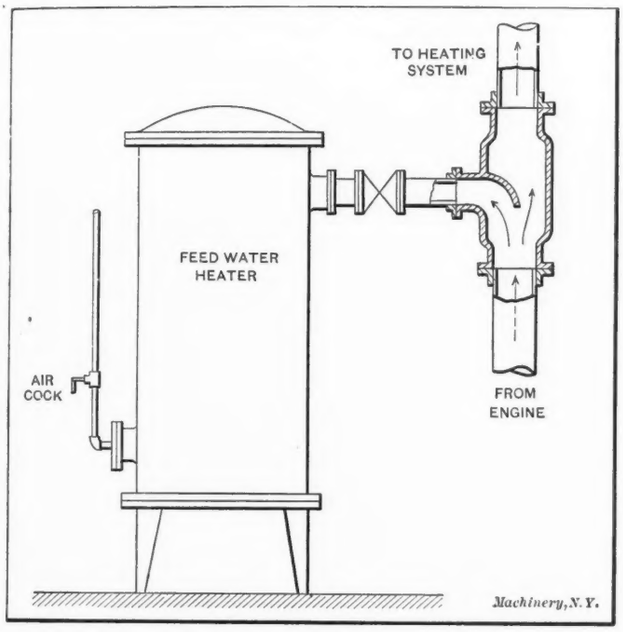


Fig. 27. Induction Method of Connecting the Heater with the Exhaust Main

feet, respectively, to the length of the main. Centrifugal pumps may be driven by direct-connected steam engines, turbines, electric motors, or may be belted to a convenient line of shafting. Fig. 21 shows a belt-driven pump of this type.

The horsepower required for driving a centrifugal pump is given by the equation:

$$\text{H. P.} = \frac{H \times V \times 8.3}{33{,}000 \times E}$$

in which H = friction head in feet,

V = gallons of water moved per minute,

E = efficiency of pump, which may be taken as 0.50 for average conditions.

In heating work the pumps are commonly run under a head

TABLE VII

Size of Delivery, Inches	Rated Capacity in Gallons Per Minute	Revolutions per Minute for Different Pressure Heads				H. P. for each Foot Pressure Head
		20-foot Head	30-foot Head	40-foot Head	50-foot Head	
2	100	780	945	1090	1210	0.063
3	240	710	850	970	1080	0.136
4	430	640	765	870	960	0.217
5	730	530	635	720	800	0.309
6	1050	480	570	650	715	0.446
7	1440	405	485	550	605	0.606
8	1880	355	420	480	530	0.791

of 20 to 50 feet. Table VII gives the capacity and power required for driving medium lift pumps at medium speeds.

Table VII is for the type of pump which would probably be used if belt-driven. If a direct-connected steam engine driven pump were employed, a larger impeller at a lower speed would be used, and for a motor or turbine-driven pump a small impeller at a high speed is required.

Heater

The water is usually heated in a closed feed-water heater with the connections reversed; that is, with the steam on the

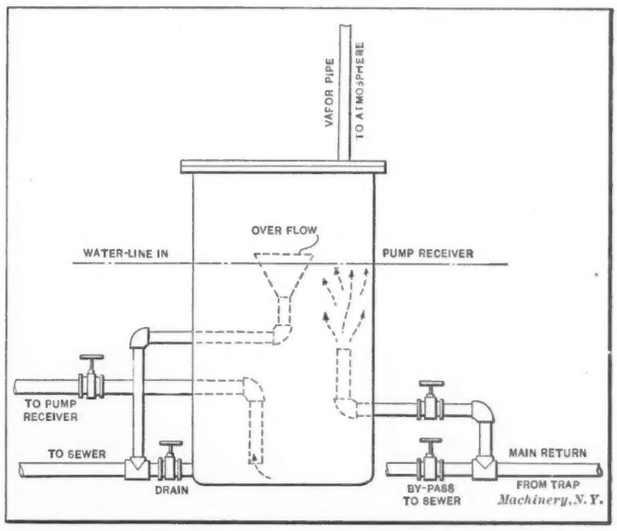


Fig. 28. Arrangement for passing the Return, a Settling Chamber or Tank

inside of the tubes and the water on the outside. Any good form of heater can be used for this purpose by providing it with steam connections of sufficient size. In the ordinary form of heater, the feed water flows through the tubes, and the connections are therefore small, making it necessary to substitute special nozzles of large size when used in the manner described. When computing the required amount of heating surface in the tubes of a heater, it is customary to assume an efficiency of about 200 heat units per square foot of surface per hour per degree difference in temperature between the water and steam.

Taking the case of a two-pipe system where the water is delivered at 200 degrees and returned at 160, the average temperature of the water passing through the heater will be, approximately, 180 degrees. If exhaust steam is supplied to the heater at atmospheric pressure, there will be a difference of 212 — 180 = 32 degrees between the steam and water, thus giving an efficiency of 200 × 32 = 6400 heat units per square foot of heating surface. Hence 6400 ÷ 210 = 30 square feet of direct heating surface that may be supplied from each square foot of tube surface in the heater. Commercial heaters are commonly built on a basis of 1/3 of a square foot of tube surface per horsepower, from which it is seen that $\frac{6400}{3 \times 210} = 10$ square feet of radiating surface supplied by each horsepower of the heater, or in other words, one commercial horsepower of heater is required for each 10 square feet of direct radiation.

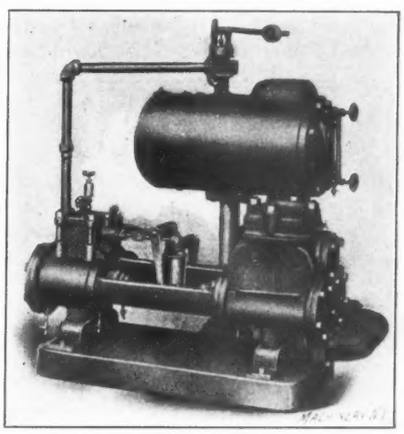


Fig. 29. Combined Pump and Receiver used for returning the Condensation to the Boilers

When there is not sufficient exhaust steam for heating requirements, live steam may be admitted to the heater through a pressure-reducing valve, provided the exhaust is purified of

oil so the condensation may be returned to the boilers. If the exhaust is not purified, and the condensation is allowed to waste, it is better to use a separate heater for the live

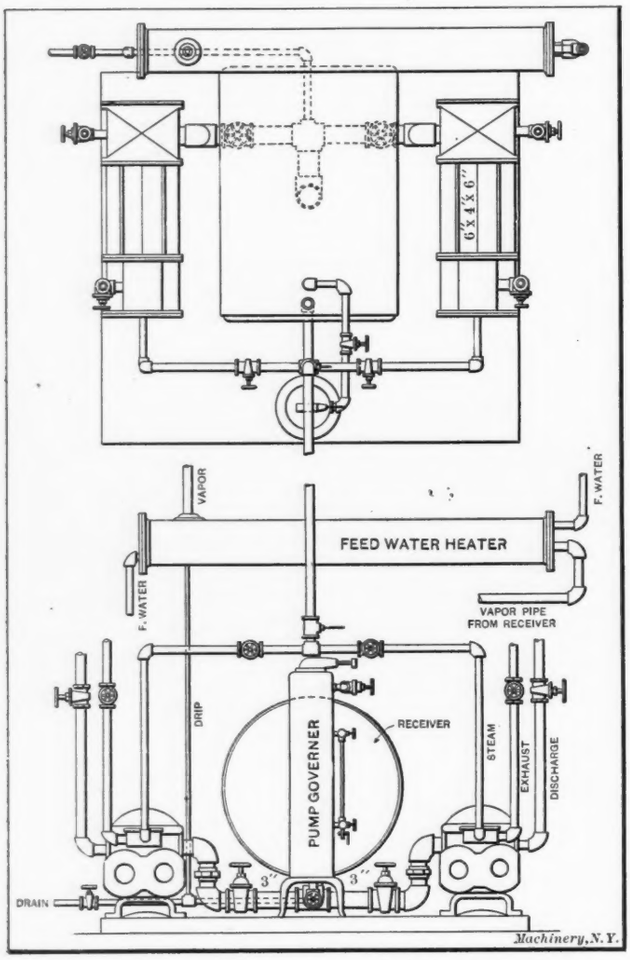


Fig. 30. Arrangement of Duplex Pump and Receiver for Large Plant

steam on the ground of economy. In the Evans-Almiral patented system of hot-water heating, the two heaters are placed in series, with the exhaust heater next to the pumps. Good results may be obtained by placing them in parallel if the water connections are so throttled as to supply the proper proportion of water to each heater. The efficiency of a live steam heater is, of course, greater than one using exhaust, owing to the higher temperature of the steam. The efficiency for any given pressure can be easily determined by the methods already given.

The general methods of making the connections between the pumps and heaters are shown by the diagrams in Figs. 22 and 23. In the first case the live steam is used in the same heater with the exhaust, and in the second, separate heaters are used, connected in parallel. It is best to provide two pumps, each capable of doing the entire work, for if the pump gives out, there is no way of warming the building until it is repaired. In making the connections, the arrangement should be such that any part of the apparatus can be cut out without interfering with the operation of the remainder. All fittings about the pumps and heaters should be of the long-turn pattern, and sweep bends of wrought-iron pipe should be used in the mains for making right-angled turns, when possible.

Extensions to Existing Plants

In making extensions to a plant already in use, the first step is to determine if there is sufficient boiler power in reserve to provide steam for the additional heating surface. If the present boilers are loaded up to their full capacity, new boilers should be installed, allowing one horsepower for each 100 square feet of direct heating surface. Next see if the supply and return mains are large enough to carry the additional radiation, using Table II for this purpose. If not, separate mains should be run from the boilers and receiving tank. Sometimes it is necessary to go back only part way to the boiler room to find a point where the mains are large enough to do the entire work without too great a drop in pressure.

If the addition is of considerable magnitude—a new building, for example—it is usually best to place an independent trap on the return, especially if it is nearer the boilers than the rest of the system. Where several buildings or wings are drained through a single return main it is often of advantage to place a trap in the return from each building and vent the receiving tank to the atmosphere. When the addition is at the extreme end of the line and the main is not of sufficient size to care for the extra load, it is usually much cheaper to run a separate supply and return, parallel to the old lines, than to enlarge them, owing to the work of discon-

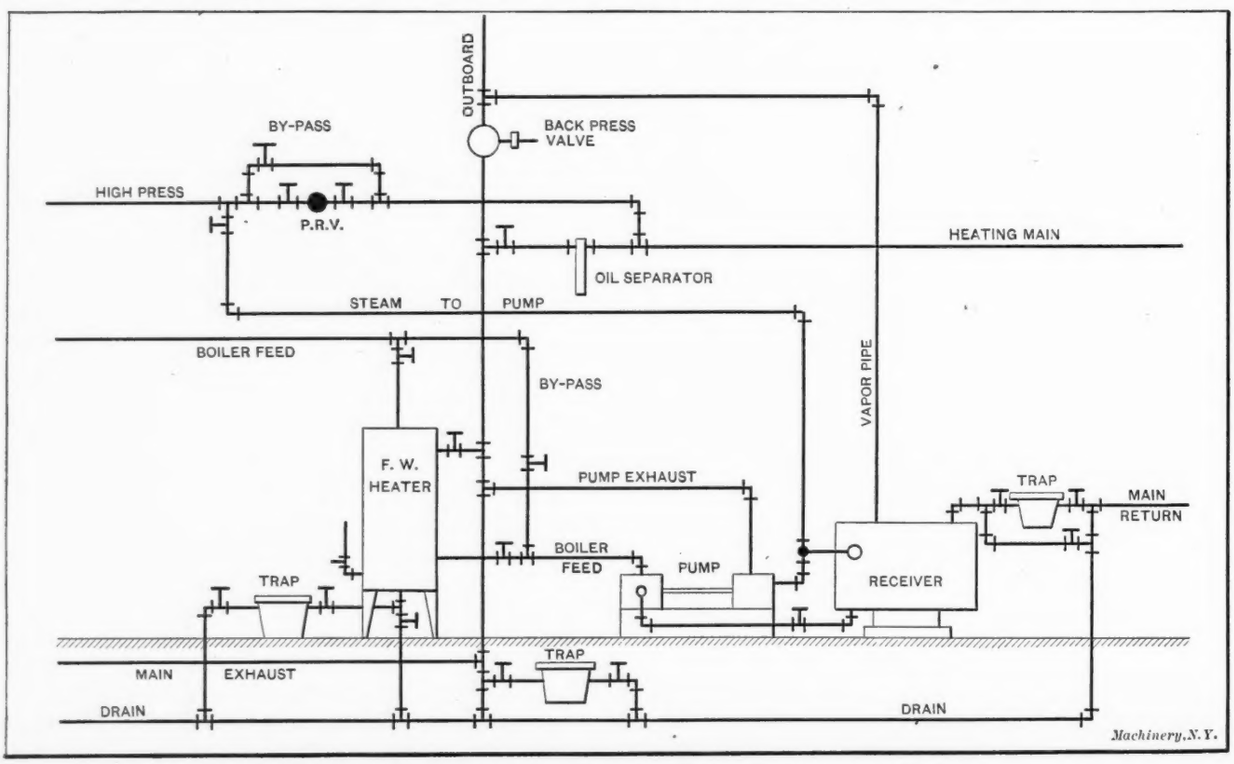


Fig. 31. General Method of Making Pipe Connections for Combined Power and Heating Plant

necting and connecting the various branch pipes along the line. Figs. 24 and 25 show methods of making connections for additions located near the boiler-room and also at the extreme end of the line. The full lines represent the old system of piping and the dotted lines the new.

Connecting Heating System to Power Plant

In connecting a heating system with a power plant, it is nearly always advisable to plan for using as much of the exhaust steam as may be necessary for heating the feed water, as this effects a constant saving in summer as well as in winter. With non-condensing engines of average economy, from 1/6 to 1/5 of the exhaust may be used for this purpose. Both open and closed heaters are adapted for use in connection with the heating systems. The former is often made to combine the oil separator, feed-water heater and purifier, return tank, and filter, as shown in Fig. 26. Either type of heater will produce satisfactory results if properly proportioned and connected. The induction method of connecting the heater with the exhaust main makes a good arrangement for a heating system. This is shown in Fig. 27, and when used, the steam for the heating system does not pass through the heater at all. This prevents any possibility of spray from the trays in the open heater being carried over into the heating system, and secures rather dryer steam than in the case of the closed heater with two connections, because the passage of the steam over the cold tubes tends to form a certain amount of moisture in the surplus steam when the whole volume is passed through the heater. The arrangement also makes it easy to cut out the heater in case of repairs.

If the condensation is to be returned to the boilers, the exhaust steam must be passed through an efficient oil separator before entering the heating system, and if there is still any tendency to priming, the return should be passed through some form of filter or settling chamber before entering the boilers. This is provided for in most types of open heaters, but if a closed heater is used, some special device must be used. A good arrangement for this purpose is shown in Fig. 28. This consists of a cast-iron settling tank so arranged that the oil on the surface can be made to overflow into the funnel by closing the valve in the pipe leading to the pump receiver. This can be done at intervals as the oil collects. The best results are generally obtained by venting the receiving tank and trapping the main return into it. If the system is fairly compact a simple trap may be used, placing it near the tank, but if two or more buildings are included, it is best to place a trap in the return from each.

In small plants a combined pump and receiver of the type shown in Fig. 29 is commonly used for returning the condensation to the boilers, but in the case of large and important heating systems it is best to use two pumps, each of sufficient capacity to do the whole work. When two pumps are used they should be run alternately to keep them in good condition. Fig. 30 shows a good arrangement for duplicate pumps and receiver. The pumps are operated automatically by means of a governor or regulator located in front of the tank, as shown. This admits steam to the pumps by means of a float valve when the water in the tank rises above a given point.

The diagram, Fig. 31, shows the general method of making the pipe connections for a combined power and heating plant. This diagram will be found useful in planning the boiler room equipment of a new plant and in remodeling an old one.

* * *

The Navy Department has recently instituted competitive rewards for low fuel and oil consumption records on naval vessels. The economies in power plant operation, which can be secured by proper instruction and encouragement of firemen and attendants, are shown by the fact that according to results thus far obtained, a saving of almost $1,000,000 a year will be effected in fuel and oil alone.

* * *

A monument was unveiled at Spencer, Mass., May 19, erected to the memory of three famous inventors, brothers, namely: Elias Howe, Jr., inventor of the sewing machine; William Howe, inventor of the truss bridge known as the "Howe truss;" and Tyler Howe, inventor of the spring bed.

PUNCH AND DIE FOR ELLIPTIC GEARS

By W. J. McDEVITT*

In the half-tone illustration, Fig. 1, are shown two elliptical gears which are punched out. The method of calculating, laying out and making the punch and die for this work may be of interest to mechanics in general. The known dimensions of the gears to be made were the major axis of the pitch line ellipses which equals the distance between the centers of rotation and the approximate eccentricity. The two gears are, of course, alike. To find the minor axis the number of teeth of a suitable pitch had to be determined. The least allowable eccentricity in this case was 0.437, and the distance between centers was fixed at 1¾ inch. According to a formula given in the text-books of the International Correspondence Schools, the perimeter of an ellipse equals

Major axis $\times$ 1.82 + minor axis $\times$ 1.315.

By assuming 18 pitch for the teeth and 1½ inch for the minor axis, we find that the number of teeth would equal

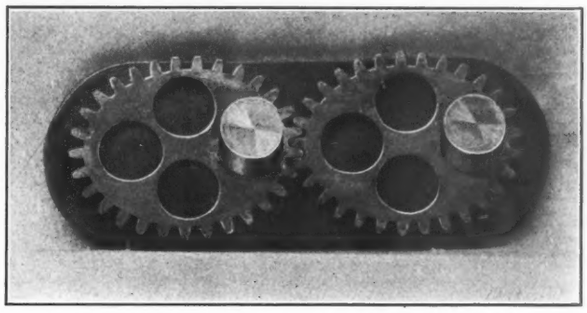


Fig. 1. Elliptic Gears Produced by Punching

29.55. Let us settle upon 29 teeth. It is evident that the number of teeth must be an odd number, inasmuch as when the gears are in the position shown in Fig. 1, the center line passing through the studs on which the gears are mounted must intersect a tooth space in one gear and a tooth in the other at the point where the teeth mesh. In other words, in each of the gears there must be a tooth at one end of the major axis and a tooth space at the other end, and this, of course, necessitates an odd number of teeth. Taking 29 teeth, as mentioned, and 18 pitch, we have

$$\text{Circular pitch} = \frac{3.1416}{18} = 0.1745 \text{ inch, and}$$

Perimeter $= 29 \times 0.1745 = 5.0605$. From the formula Perimeter = major axis $\times$ 1.82 + minor axis $\times$ 1.315, we have

$$\text{Minor axis} = \frac{\text{perimeter} - \text{major axis} \times 1.82}{1.315}$$

$$= \frac{5.0605 - 1.75 \times 1.82}{1.315} = 1.426$$

Hence, major pitch diameter = 1.750 inch, and minor pitch diameter = 1.426 inch.

[The formula here given for finding the perimeter of an ellipse is only approximate. More accurate formulas are ordinarily given in the standard hand-books, but these formulas require a table of constants for different eccentricity of the ellipse. The formula above, while less accurate, has the advantage that it requires but two constants which can be retained by memory. For practical work of the character described in this article the accuracy obtained was apparently sufficient.—EDITOR.]

The next step in the making of the tools for these gears was to lay out the ellipse on the drawing board and the construction used was taken from a book on mechanical drawing by Prof. Faunce of the Massachusetts Institute of Technology. This method is as follows:

Having given the axes, to draw a curve of tangential arcs of circles approximate to the ellipse. Referring to Fig. 2 *AO*

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is the semi-major axis and *OB* the semi-minor axis. Draw a rectangle with the axes as sides. *AOBC* is one-quarter of the rectangle. Draw *AB*. From *C* draw *CMP* perpendicular to *AB* and meeting *BO* produced at *P*. Make *OE* equal to *OB*. With *AE* as a diameter draw a semicircle *AKE*. Produce *OB* to *K*. Make *OL* = *BK*. With center *P* and radius *PL* draw the arc *LN*. Make *AD* equal to *OK*, and with center *M* and radius *MD* draw the arc *DN*, meeting *LN* in *N*. Draw *NMR* and *PNS*. With center *M* and radius *MA* draw *AR*; with center *N* and radius *NR* draw *RS*; with center *P* and radius *PS* draw an arc through *B* from *S*. Repeat this in each of the quadrants.

By laying out the ellipse as carefully as possible at four

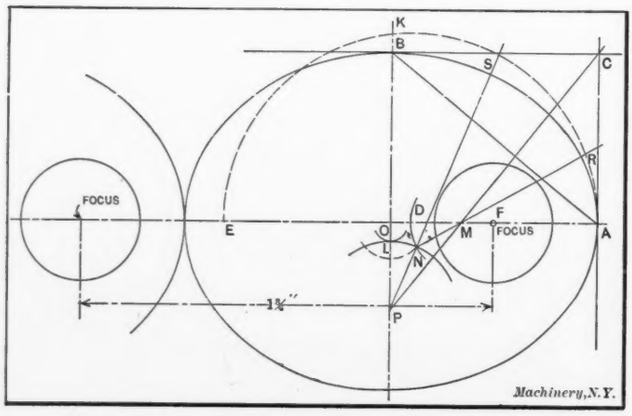


Fig. 2. Method of Laying out an Ellipse by Eight Circular Arcs

times the size and then measuring to the nearest hundredth inch, gives the following distances for pitch line:

$$PS = PB = 4.300 \text{ inch, or } \frac{4.300}{4} = 1.075 \text{ inch.}$$

$$NR = NS = 3.160 \text{ inch, or } \frac{3.160}{4} = 0.790 \text{ inch.}$$

$$MA = MR = 2.320 \text{ inch, or } \frac{2.320}{4} = 5.580 \text{ inch.}$$

As there were nine different centers required on the face of the punch, and it was convenient to lay them out from the center *O*, the following distances were used:

$$OM = 0.875 - 0.580 = 0.295 \text{ inch.}$$
$$OP = 1.075 - 0.713 = 0.362 \text{ inch.}$$
$$ON = \frac{0.590}{4} = 0.147 \text{ inch.}$$
$$MN = 0.790 - 0.580 = 0.210 \text{ inch.}$$
$$PN = 1.075 - 0.790 = 0.285 \text{ inch.}$$
$$\text{Addendum} = \frac{1}{18} = 0.0555 \text{ inch.}$$

Then major diameter of blank = 1.75 + 0.111 = 1.861 inch.
Minor diameter of blank = 1.426 + 0.111 = 1.537 inch.
To find distance *OF*, the center of rotation, we have:

$$OF = \sqrt{OA^2 - OB^2} = \sqrt{0.875^2 - 0.713^2}$$
$$= \sqrt{0.2572} = 0.5072 \text{ inch.}$$

According to the properties of the ellipse, the eccentricity

$$e = \frac{OF}{OA} = \frac{0.5072}{0.875} = 0.579.$$

It will be found that three cutters are required to cut the teeth.

To find the cutters to use for different circles, we have
$1.075 \times 2 = 2.150$, and $2.150 \times 18 = 38.7$ teeth.
$0.790 \times 2 = 1.580$, and $1.580 \times 18 = 28.44$ teeth.
$0.580 \times 2 = 1.160$, and $1.160 \times 18 = 20.88$ teeth.

The center of a tooth or center of a space should be at *A*. As there were several shifts to be made and changing of cutters the work required considerable care, but the job was done by an exceptionally good workman. After the punch was cut and hardened it was used to broach out the die which was worked out as near as possible. These tools were made at Cummings Machine Works, Boston, Mass.

The punch and die were of the simple push-through style. The hole in the elliptic gear for the shaft as well as the other three holes through it were drilled in a jig. As the gears have an odd number of teeth, they must be placed in the jig in the same position each time, this position being determined by a pilot in the jig which fitted into the tooth space on the line of the major axis. In this way the hole of which the focus is the center would be always either at the tooth end or at the space end of the gear. The original idea was to have a roughing and a shaving punch and die, but only one set was made and the result proved satisfactory.

* * *

CONCISE AND DEFINITE INFORMATION

We sometimes wonder if the readers of MACHINERY fully appreciate the concise and definite information that is spread before them. The substance of long articles is often given in notes of a few lines. As an example of the type of articles which tell little or nothing and use a good many words to tell it, we present the following clipped from a Sunday newspaper:

Uranium and Tellurium Solder

Science has at last discovered a perfectly solid solder for metal joints. Just what this will mean in future decades to railroads and in other metallic features, where a solid jointure is so desirable, only experience and actual wear and tear in active use can disclose. However, the fact that is claimed for the new uranium and tellurium solder mixture will practically compose a solid joint between two metals is of vast interest.

In modern electric street railway systems the absence of a solid joint causes millions to be spent annually in connecting rails by wires. Numerous attempts have been made with other solders to form a continuous rail out of the ordinary steel rail.

All these attempts have proved failures. Now comes the assertion that uranium and tellurium in certain proportions will form an absolutely perfect union from a metallic standpoint when put between two steel rails.

The rarity and costliness of the two metals involved in the new composition robs the discovery of much of its present utility, but it can still be used at many points where, in delicate machinery, a solid joint is highly to be desired. This is especially true as regards delicate apparatus used in the scientific laboratories where the solidarity of the metallic jointure frequently would mean success where at present this is unattainable.

Just what the exact proportions of uranium and tellurium are that must be employed in the new solid metallic jointure is not publicly known. It is the claim founded on alleged actual achievement that is most interesting to scientists and to the men actively engaged in the varied branches of commercial chemistry and engineering.

An analysis of the statements in the above discloses first that the solder is suggested for uniting rail joints of electric railways—a most brilliant idea! An uninformed reader might infer that engineers were vainly seeking for some solder or other means of efficiently joining street railway rails. As a matter of fact, we have the electric welded joint, the cast-iron joint, the thermit joint and the fish-plate joint with cast zinc filling, all of which are efficient and satisfactory although more or less expensive. The best copper bonds also are fairly efficient and satisfactory. In the second place, the note proposes an impractical solder—impractical because the materials are rare and costly, so costly that it would be totally out of the question to use them for commercial purposes. Moreover, there is no experience quoted indicating that the solder would work efficiently in the situation suggested. Thirdly, the precise constituents of the solder are unknown! The analysis, therefore, discloses that the entire proposition is tenuous and without substantial foundation for commercial purposes. Granted that the fact of a uranium and tellurium solder having been discovered is of some popular interest, the substance of the foregoing lengthy and misleading statement could have been expressed about as follows:

"A new solder composed of uranium and tellurium has been discovered, the exact proportions of which have not been made public. It is believed that this solder will be of considerable value for uniting parts of scientific instruments where it is essential that a perfect union be secured and the cost is not prohibitive. The rarity and high cost of the components probably will limit the use of the new solder to experimental and special purposes."

INTERESTING TOOLS AND METHODS OF CINCINNATI SHOPS—4

THE CINCINNATI SHAPER CO.

By ETHAN VIALL*

The special and original devices and shop kinks in use in the shop of the Cincinnati Shaper Co., are almost unlimited and only a small number of them can be noticed in this article. Of course a good many of them are applicable only to shaper construction, though they may contain, in themselves, a suggestion or idea which may be used on other work. In fact, the principal value of a description or illustration of a "shop kink" to the average toolmaker or designer, is its suggestiveness; that is, it may contain just the idea for which the reader has been searching, and thereby assist him to overcome a difficulty in a line which is, perhaps, radically different from the one in which the "kink" was originally used. It is for this reason that a pictorial panorama of the interesting shop devices in use not only in Cincinnati, but in other cities, is run in these pages each month.

Tool Turret for a Shaper

Toolpost turrets of various shapes and sizes are in common use on lathes, but one seldom sees a revolving tool-holder on a shaper, though it is extremely useful wherever several tools are to be used on a number of pieces of the same kind. Such a tool-holder with four tools in place, is illustrated in Fig. 1.

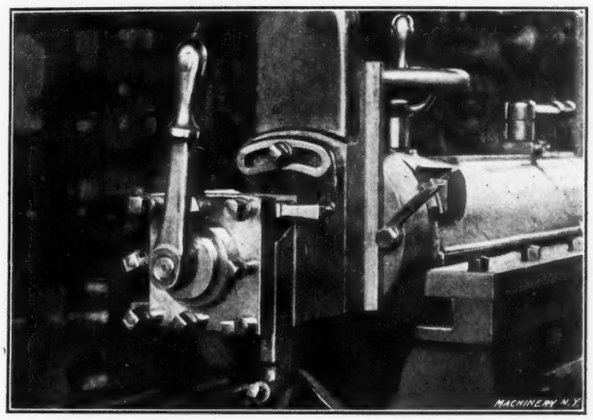


Fig. 1. Shaper with Turret Toolpost

Broaching D-Washers—Keyseating on a Shaper

Many small parts such as D-washers may be broached out to advantage in a shaper, as shown in Fig. 2. For this work, the clapper-block is, of course, either removed or locked, and the shank of the broach is held, preferably, in a split block or socket, so as to be easily removed. In the example shown, the drilled washer is placed in a U-shaped socket in the face of a foot-plate, which allows the operator to put a washer in place at every stroke of the ram, only stopping the machine when the shank of the broach is full.

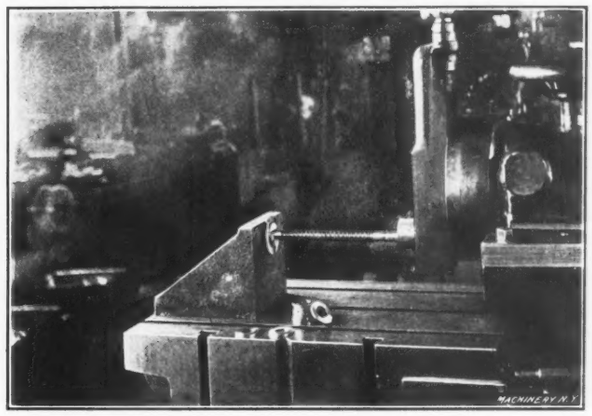


Fig. 2. Broaching D-Washers in the Shaper

Cutting keyways in pulleys is a job often done on a shaper, but in the shop under discussion, a regular keyseating attachment is made which practically makes a keyseating machine out of an ordinary shaper. A front view of this attachment at work on a big pulley, is shown in Fig. 3. The feeding of the keyway cutter is done by turning the handle *A*. Fig. 4 shows a rear view of the same job, while Fig. 7 shows the construction of the attachment in detail. The ball-and-socket connection of the cutter bar to the shaper head, is to be noted in this illustration, as well as the method of feeding the cutting tool. The adjustable stop-ring and set-screw *B*, Fig. 3, show plainly the way the depth of the cut is gaged. Fig. 5 shows a large cone pulley being keyseated. This last illustration is included because it shows the vise jaws set on the outside of the pulley, while the large single pulley was chucked from the inside of the rim. The vise jaws, however, do but little more than to center and steady the pulley. As the tool cuts only on the return stroke of the ram, the entire pull is against the angle-plate body of the vise.

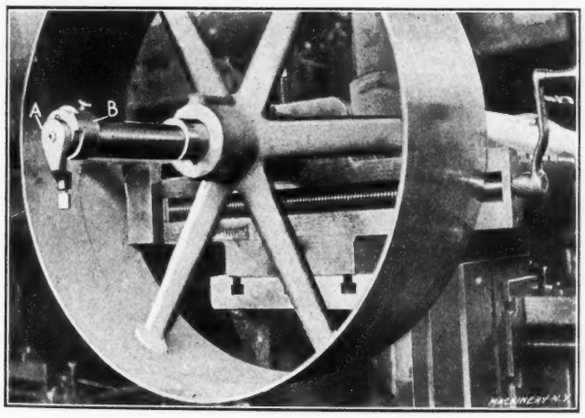


Fig. 3. Keyseating a Large Pulley—Front View

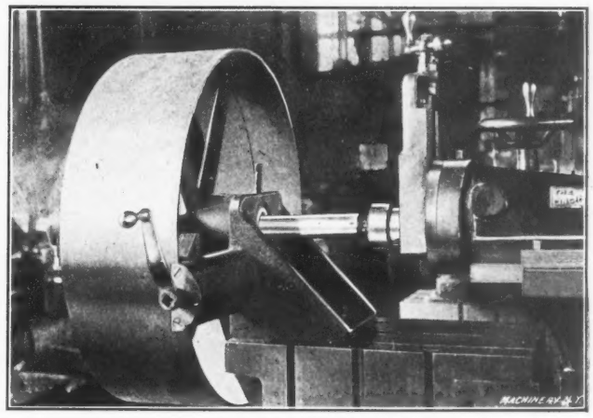


Fig. 4. Keyseating a Large Pulley—Rear View

Miscellaneous Shaper Appliances

Bushings with solid keys are cut in an automatic feeding fixture, Fig. 6, in which the feed worm is worked by the rod *A*, which is attached to the head of the shaper ram. The bushings, a finished one of which is shown at *B*, are placed on a shouldered mandrel and held between the centers of the fixture. The tail of the dog is held between the drivers *D* and *E*, in such a way as to avoid any unnecessary play. If, in setting, it is required to revolve the mandrel, it may be done by turning the small crank *F*. The worm-wheel is also an indexing disk and may be set or locked, at various points, by using the arm and pin *G*, which makes the fixture suitable for other work not requiring the automatic feeding device.

Figs. 8 and 9 show two shaper jigs for holding special parts, which need no explanation, and in Fig. 10 is shown a special motor-driven mill used to machine the surface of the shaper base on which the bottom of the table support rests. As this milling device travels on the horizontal table ways, the surface milled must necessarily be parallel to them, which is what is required in order that the support may properly do its duty.

*Associate Editor of MACHINERY.

The semi-circular spots on clamp-bolts are accurately reamed to the correct radius by using the special left-hand spiral reamer *A*, Fig. 11. *B* and *C* are guide bushings, fitting the hole in the casting *D*; *E* is the clamping bolt, and *F* is a size-testing bar. By using reamer *A* to finish the recess in the bolt, a perfect fit is obtained and, in consequence, only a slight tension is needed to lock the parts securely.

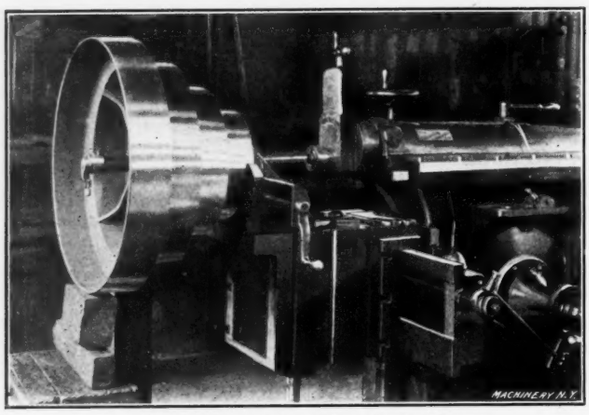


Fig. 5. Keyseating a Large Cone Pulley

Graduating and Numbering Swivel Heads—Testing Vise Jaws

Shaper swiveling heads are graduated on a machine built along lines similar to several other Cincinnati graduating machines, though it differs in several points from them. Fig. 12 is a front view of the device. It may be run either by hand or by means of the motor attached. This motor is an old fan motor and the method of belting, as shown in this illustration and in Fig. 13, is interesting. These two engravings show the cam motion for obtaining the one long and the four short graduating strokes, as well as the various adjustments, so plainly that no explanation is needed. After graduating the swiveling heads, the degree numbers are rolled in on the machine shown in Fig. 14, an enlarged view of which is shown in Fig. 15. An inspection of the last engraving will show that two sets of figures and two sets of "half gears" are used, so that the figures may be pressed into two different sizes of swivel heads on the same machine.

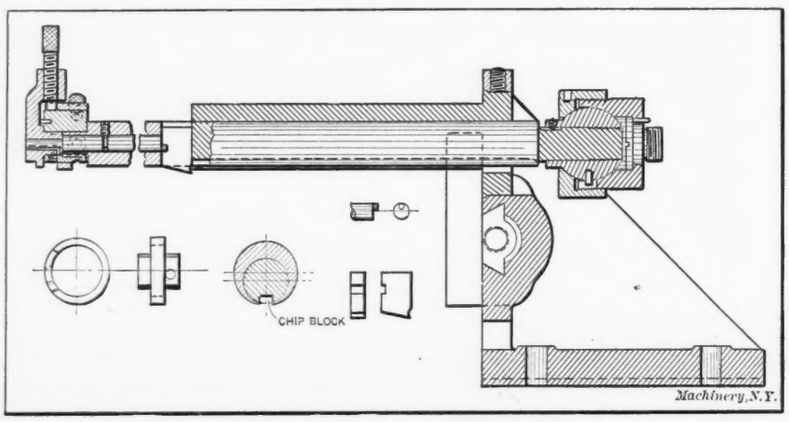


Fig. 7. Details of the Shaper Keyseating Attachment

Shaper vise jaws are tested for parallelism and the correct position of the pointer relative to the graduations on the base, on the machine shown in Fig. 16. A Brown & Sharpe dial indicator is carried on the end of a small ram, similar to that of a shaper, and it is fed out or in by means of a handwheel. The tops of the vise ways are tested by turning the vise one-quarter around and setting the indicator as shown in Fig. 17.

In Fig. 18 are illustrated three adjustable scraping blocks,

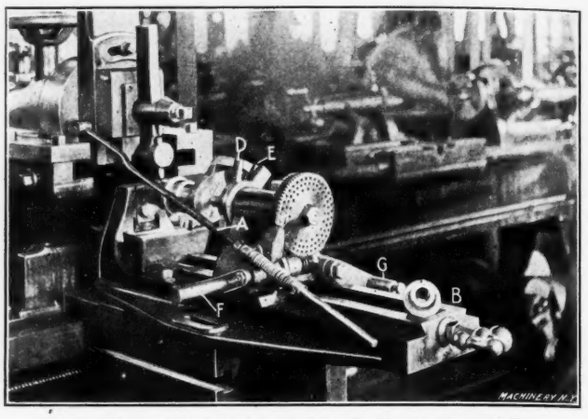


Fig. 6. Shaper Attachment for Cutting Bushings with Solid Keys

the variation in size being obtained by taper gibs which may be firmly locked wherever set. *A* is a block used for marking and gaging while scraping for stroke nuts; *B*, for slides and *C*, for column V's. In using these scraping blocks, the procedure is much the same as in using ordinary flat scraping surface plates, the surface being smeared with lead, the block worked back and forth, and the metal touched up with a hand scraper according to the marking. For scraping in ram slides and ram clamps, as they are too large and heavy to be worked back and forth by hand, the machine shown in Fig. 19 has been especially designed. This scraping machine is portable and may be attached to any shaper under construction. Bolted to the ram head is a bracket which fits into the fork of the rocking arm of the machine in such a way as to be easily lifted out, when it is necessary to lift the ram clear of its bearings, with the chain hoist. Fig. 20 is another view of the machine showing the arm and crank motion, the position of the motor, rheostat and switch, and the gearing.

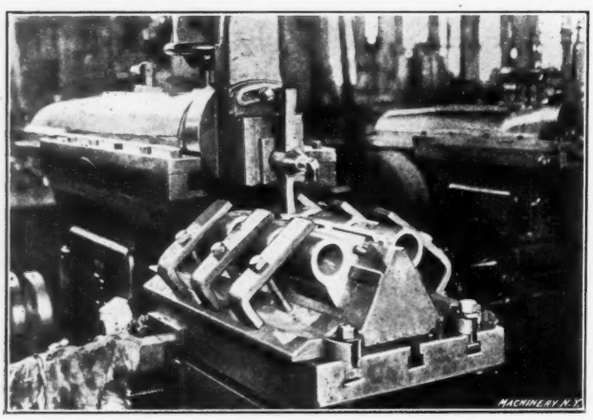


Fig. 8. Shaper Fixture for Machining Dovetails

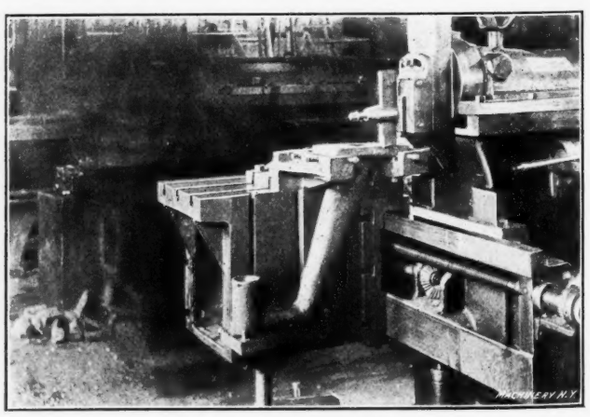


Fig. 9. Special Shaper Fixture

Turning Gear Blanks and Disks for Setting Cutters—Grooving Solid Journal Boxes

Change gear blanks are first bored out, the hub faced and the keyway cut; then they are placed on a keyed mandrel and

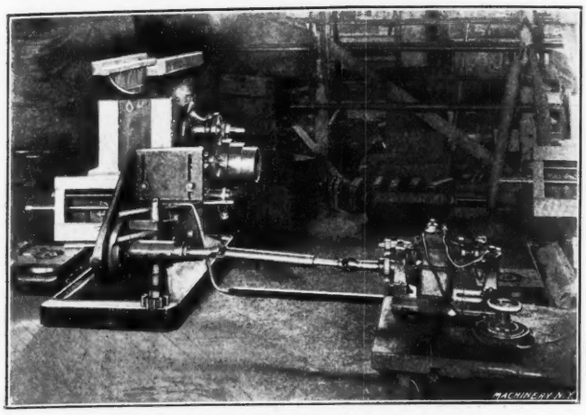


Fig. 10. Portable Electrically-driven Milling Attachment for Surfacing Shaper Base

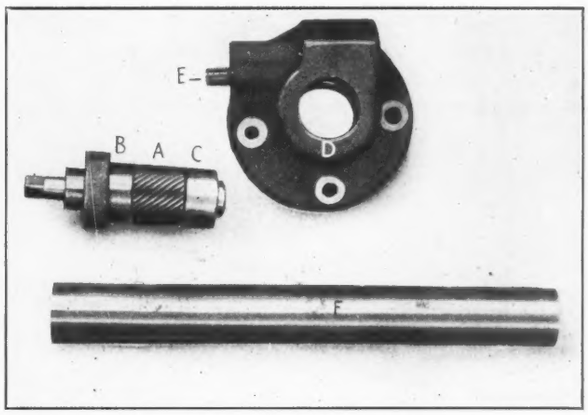


Fig. 11. Special Tools for Reaming and Testing Clamp Bolts

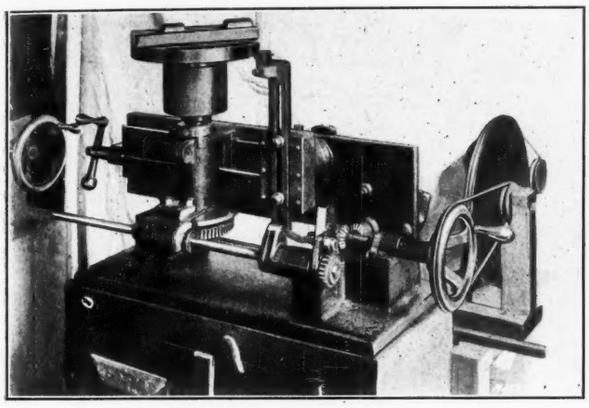


Fig. 12. Graduating Machine—Front View

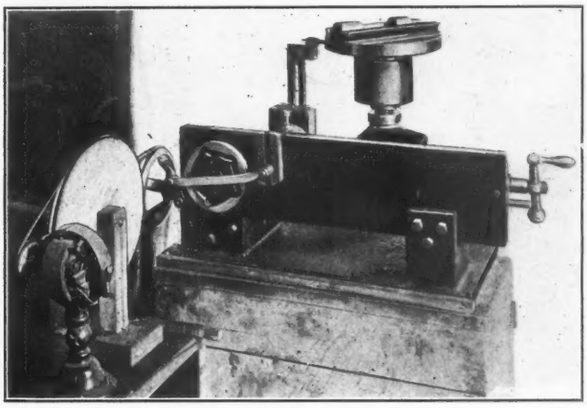


Fig. 13. Graduating Machine—Rear View

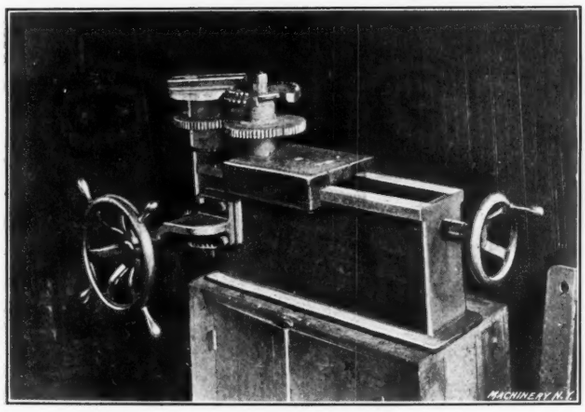


Fig. 14. Machine for Numbering Angular Graduations

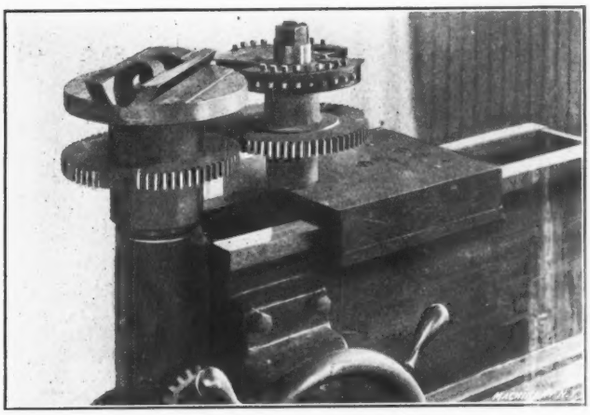


Fig. 15. Enlarged View of Numbering Machine Head

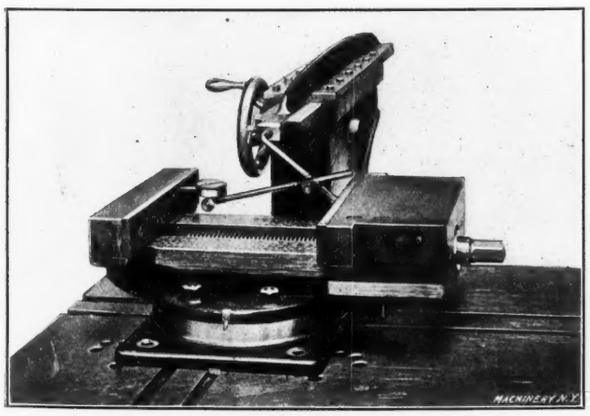


Fig. 16. Shaper Vise-testing Machine—Testing Jaw Faces

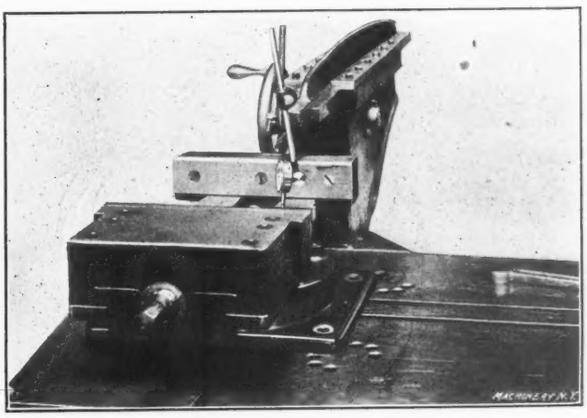


Fig. 17. Testing the Ways of a Shaper Vise

finished in a lathe fitted with a special tool carriage having two sets of tools, a roughing and finishing set, shown in Fig. 23. At *A*, Fig. 21, is a blank in position for roughing and at *B* are a number of mandrels and gear blanks. A gear is pressed on a mandrel while the cut is being taken on the one in the lathe, so as not to lose time. An arbor press which is used for this purpose is conveniently located at *C*.

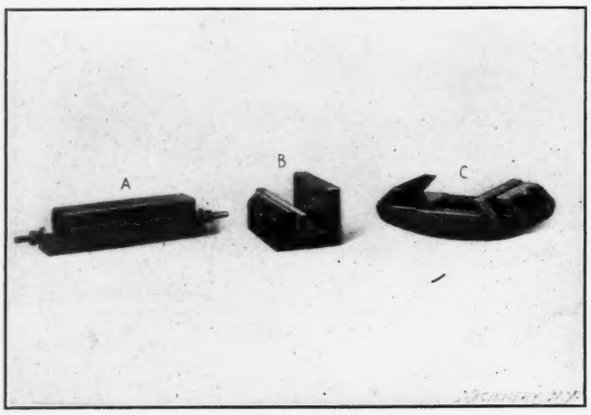


Fig. 18. Test Blocks used in Connection with Scraping

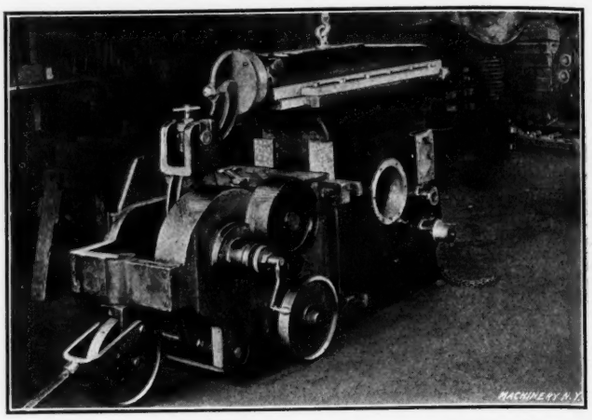


Fig. 19. Portable Machine for Moving the Ram when scraping it

In cutting gear teeth, it is common practice to set the cutter with the outside diameter of the blank and then raise the table or lower the cutter a certain number of thousandths to secure the right depth of the teeth, but to do away with the errors that are bound to creep in through setting by an off-size blank or miscalculation in the setting, a series of setting blanks, Fig. 24, is used, which are exactly the diameter that the gear for which they are marked should be at the bottom of its teeth, so that if one of these setting blanks is put on a mandrel and placed between the centers, the gear cutter may be set so that it just barely clears the rim and the operator is absolutely certain of its correctness without having to check up his table height or measure the outside of a gear blank when setting.

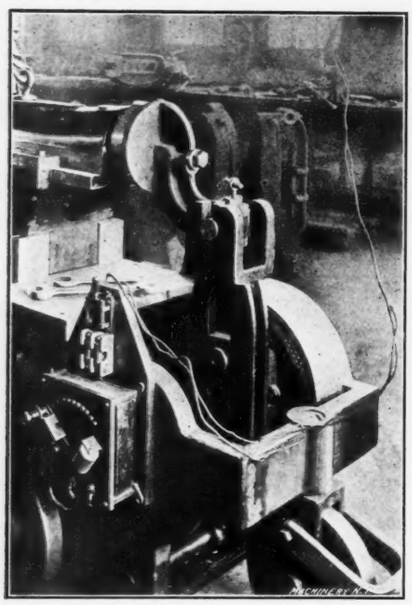


Fig. 20. Enlarged View of the Scraping Machine, showing Starting Box, Slotted Cross-head, etc.

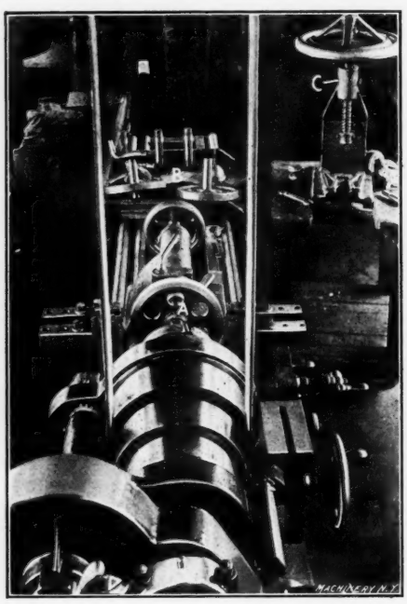


Fig. 21. View of Lathe especially fitted for Turning Gear Blanks

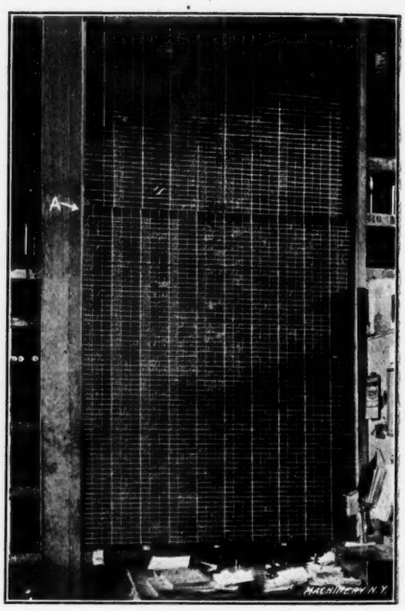


Fig. 22. Counterbalanced Stock Report Boards

The principle of the solid journal box oil-grooving device, shown in Fig. 25, which is used on a drill press, has been described before, but it will stand describing again for the benefit of those who haven't seen one. The grooving cutter *A* is set into the holder *B*, which fits into the drill press spindle.

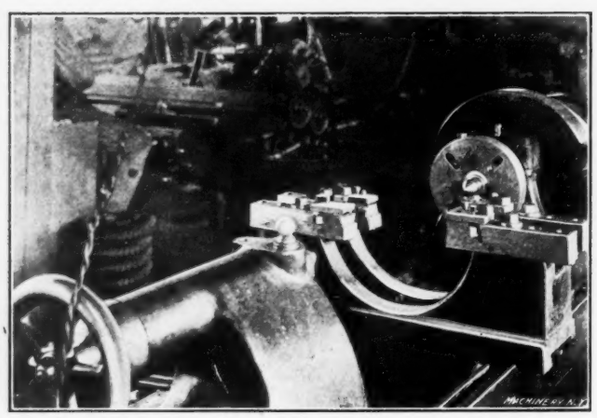


Fig. 23. Double-head Tool Carriage for Turning Gear Blanks

Fig. 24. Disks of Various Sizes for Setting Gear Cutters to Depth

When in use, this holder fits down over the guide *C* which has a long piece *D* in it, something like a key, but which may be forced outward by a taper wedge back of it, operated by pushing in the member *E*; this forces the wedge upward and pushes the piece *D* out against the cutter *B*. By working the drill press spindle up and down and gradually pushing in the member *E*, the oil groove is easily cut. Fig. 26 shows a journal box in place, and also shows the slanting slot *F* in the end of part *E* by which the taper wedge is forced upward.

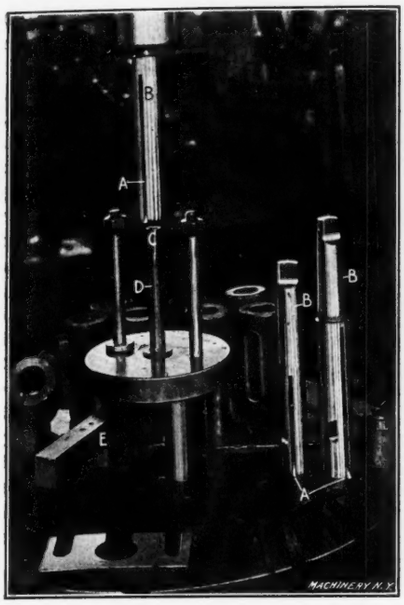


Fig. 25. Fixture for Cutting Oil Grooves in Solid Journal Boxes

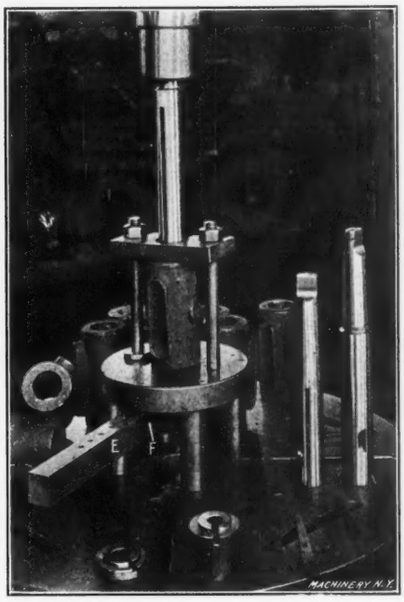


Fig. 26. Oil Groove being cut in Solid Journal Box

Miscellaneous Devices

The big ruled blackboards which are used to keep track of the number of pieces in stock or orders for the various machine parts, are shown in Fig. 22. These big boards are counterbalanced, like a window, and when one is down where it can be easily read, or chalked in, the others are up out of the way. The first column shows the number of the parts; the second column the number of pieces in stock and the third column the number on order. In the engraving, one full board is shown and, above *A*, a part of another.

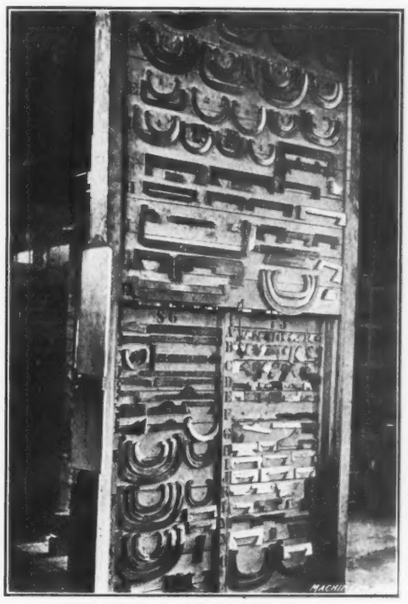


Fig. 27. Counterbalanced Gage Boards

Fig. 27 shows a set of counterbalanced gage boards, which are neat and save a great deal of space as well as trouble, for the boards are easily pulled down and no step ladder is needed to reach the upper ones.

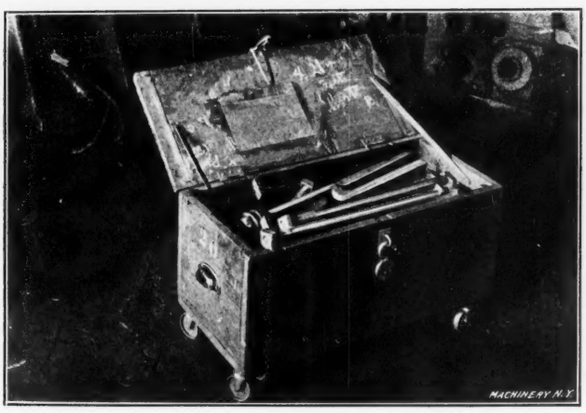


Fig. 28. Type of Chest in which Bolts and Clamps for Each Job are kept

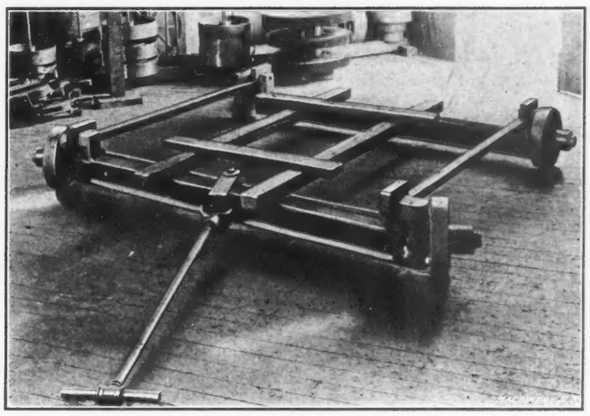


Fig. 29. Heavy Machine Moving Truck

A splendid time- trouble- and temper-saving plan carried out here, is to keep all the bolts, blocks, clamps or wedges, needed to set up any regular job, in a chest (Fig. 28), the key of which is accessible only to those who have a right to it.

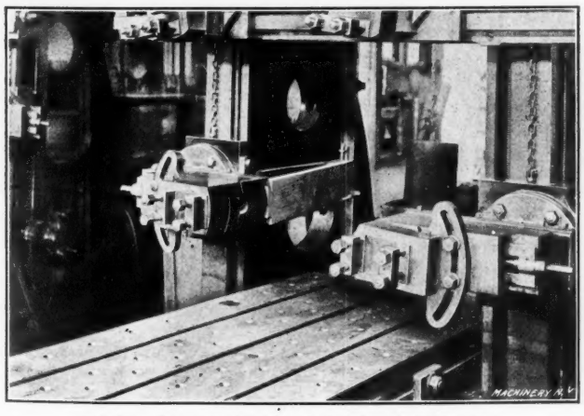


Fig. 30. Planer equipped with Reinforced Side-heads

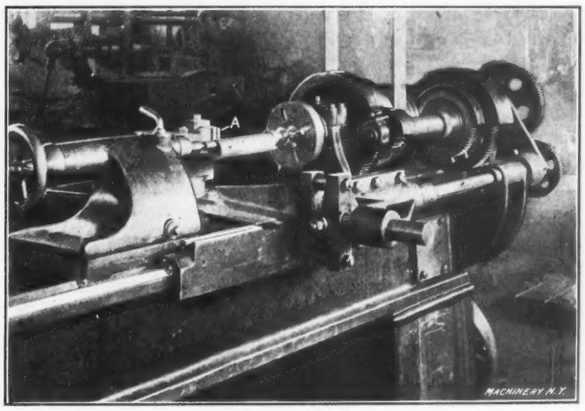


Fig. 31. Lathe with Special Eccentric Turning Attachment and Tool

Each chest is numbered to correspond to the parts to be machined, and as it is on large casters, it is easily rolled from the tool storage room to the machine on which the work is to be done. By this system a man doesn't have to keep a whole junk pile near his machine, from which to dig out his bolts or clamps, with the chance that he won't find what is needed after a half hour's wasted search, and will have to make something or rob his neighbor.

Heavy machines may be easily moved to places not accessible to a crane, by using the truck shown in Fig. 29, which is very low and strong. Special note should be taken of the steering knuckles, the long hubs of the wheels and the method of connecting the two axles.

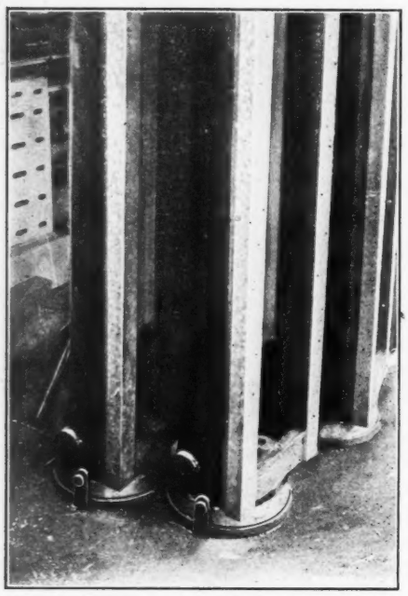


Fig. 32. Shaper Rams with Brass Caps attached to the Finished Ends for Protection

Fig. 30 shows a planer fitted with special cross-slides and braces for its side heads, in order to secure the proper rigidity for high, narrow work.

In handling shaper rams after the heads have been finished, it has been found impossible to prevent damage to them unless the finished head is protected in some way; for this purpose easily applied brass caps have been made which are put on as shown in Fig. 32.

Instead of using two centers for eccentric work, a lathe has been fitted up as shown in Fig. 31. The mechanism is plainly shown, but the point I wish to bring out is that a single pointed cutting tool will not turn a true eccentric, as the motion of the piece being turned and its relation to the cutting point varies considerably, so that a tool like the one shown at *A* must be used to obtain the desired result.

* * *

PENSION FUND OF THE U. S. STEEL CORPORATION

The United States Steel Corporation announced early in May that it has established a pension fund for its employes. The sum of $8,000,000 has been set aside for this purpose which will be consolidated with a $4,000,000 fund given some years ago by Mr. Andrew Carnegie for the same object. The aggregate amount will be known as the United States Steel and Carnegie Pension Fund, and the net proceeds will be administered by a board of twelve trustees for the benefit of the employes of all subsidiary companies of the United States Steel Corporation. It is understood that under the tentative arrangement for the distribution of the proceeds from the fund, injured employes will receive part of their wages during the time of their disability. Single men are to receive 35 per cent of their wages, and married men 50 per cent, with an extra 5 per cent for each child under 16, and 2 per cent for each year of service over five. For permanent injuries lump sums are provided, based on the extent of the disability. In cases of death, the widow and children will receive 1½ years' wages with an additional 10 per cent for each child under 16, and 3 per cent of each year of service over five.

* * *

Don't let your work fall below inspection par by sacrificing quality for quantity.

DETERMINING DIMENSIONS OF GEARS FROM SAMPLES*

By E. WINSLOW BAXTER†

Many articles have been published in the engineering press on the subject of gearing, and formulas have been given for the solving of the different problems which arise in designing gear transmissions. There is another phase of the subject, however, which is seldom mentioned. This is the duplication of worn out or broken gears sent to the gear cutting shop by the customer who wants a new gear "just like the sample." Often these samples are accompanied by instructions, sketches, or blueprints which render the work of duplication simple, but a large number are sent in by customers to whom all gears are "cog-wheels," and the information needed to reproduce the old gear must be obtained from the sample.

The writer intends to give in the following a few of the methods by which problems of this kind may be solved, although these methods are by no means original. For testing the pitch of gears a prominent firm sells a set of three spur-gear gages having teeth cut on their periphery for all the principal diametral pitches. Such a set of gages is very handy for measuring the pitch of gear samples. However, all gears are not cut with standard diametral pitches. Sometimes they are cut with an odd circular pitch which must be determined by calculation. In the engraving accompanying the table of spur gear formulas is given the nomenclature used for regular involute teeth. All the formulas given in the following are based on the proportions given in the table.

Spur Gears

Assume that we are to reproduce a spur gear, the teeth of which are not worn more than to make it possible to measure the outside diameter with reasonable accuracy. From the known outside diameter and the number of teeth we can find the circular pitch required for selecting the proper cutter for cutting the gear. The formula used is as follows:

$$P' = \frac{3.1416 \times O}{N + 2}$$

Assume, for example, that the sample gear has 18 teeth and that the average of a number of different measurements for the outside diameter taken at different points is 4⅜ inches. Substituting these values in the formula gives:

$$P' = \frac{3.1416 \times 4.375}{18 + 2} = 0.687, \text{ or practically } 11/16 \text{ inch.}$$

When the circular pitch is found it can be approximately converted into standard diametral pitch by tables published in nearly all gear catalogues, and also in MACHINERY's Reference Series No. 15, "Spur Gearing." The proper cutter to use can then easily be selected.

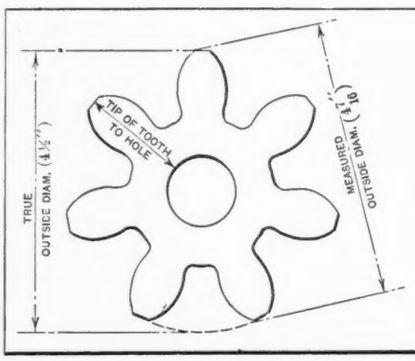


Fig. 1. Method of Measuring the Outside Diameter of a Gear with an Odd Number of Teeth

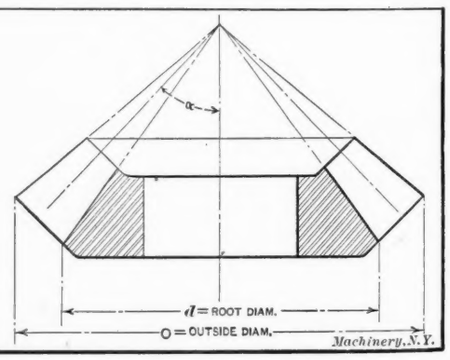


Fig. 2. Nomenclature for Bevel Gears

If the sample gear is worn so that the outside diameter cannot be accurately measured, measure the bottom diameter and substitute in the formula below:

$$P' = \frac{3.1416 \times d}{N - 2.3142}$$

* For additional information relating to gearing, see MACHINERY'S Reference Series, No. 1, "Worm Gearing," No. 15, "Spur Gearing," No. 20, "Spiral Gearing," and No. 37, "Bevel Gearing."

† Address: 33 Flynt St., Norfolk Downs, Quincy, Mass.

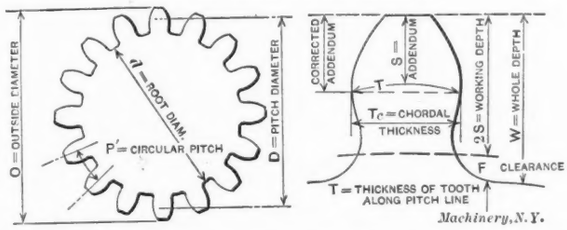
As an example assume that the sample gear has 50 teeth and that the root diameter is 3.97 inches. Then:

$$P' = \frac{3.1416 \times 3.97}{50 - 2.3142} = 0.262 \text{ inch.}$$

This circular pitch corresponds almost exactly to 12 diametral pitch.

If the sample gear has an odd number of teeth and the pitch is coarse, the outside or root diameters cannot be obtained with sufficient accuracy by direct measurement, as plainly shown in Fig. 1. In this case, however, we can measure from the hole to the tip of one tooth, multiply this dimension by 2, and add the diameter of the hole, the total sum then being the true outside diameter.

TABLE OF SPUR GEAR FORMULAS



Machinery, N.Y.

Name	Symbol	In Terms of No. of Teeth, Diametral Pitch or Pitch Diameter	In Terms of Circular Pitch	In Terms of Diametral Pitch	In Terms of Addendum	In Terms of Thickness
Number of Teeth.	N	.....	.....	.....	.....	.....
Circular Pitch...	P'	.....	.....	$\frac{3.1416}{P}$	3.1416 S	2 T
Diametral Pitch.	P	.....	$\frac{3.1416}{P'}$	.....	$\frac{1}{S}$	$\frac{1.5708}{T}$
Addendum	S	.....	$\frac{P'}{3.1416}$	$\frac{1}{P}$	.....	0.6366 T
Thickness of Tooth	T	.....	$\frac{P'}{2}$	$\frac{1.5708}{P}$	1.5708 S	.....
Chordal Thickness	T_c	$D \times \sin \frac{90^\circ}{N}$	.....	.....	.....	.....
Clearance	F	.....	$\frac{P'}{20}$	$\frac{0\ 1571}{P}$	0.1571 S	$\frac{T}{10}$
Working Depth..	2S	.....	$\frac{2P'}{3.1416}$	$\frac{2}{P}$	2 S	1.2732 T
Whole Depth.....	W	.....	0.6866 P'	$\frac{2.1571}{P}$	2.1571 S	1.3732 T
Outside Diameter	O	$\frac{N+2}{P}$	.....	.....	.....	.....
Pitch Diameter..	D	$\frac{N}{P}$	.....	.....	.....	.....
Root Diameter...	d	$\frac{N-2.3142}{P}$	.....	.....	.....	.....

Bevel Gears

In duplicating bevel gears it is necessary to know the number of teeth in the mating gear and the angle of the shafts on which the two gears run. The center or pitch cone angle α (Fig. 2) of the gear must first be found.

Let N_1 = number of teeth in sample,
N_2 = number of teeth in mating gear,
α = pitch cone angle of sample,
γ = shaft angle.

Then for 90-degree shaft angles:

$$\tan \alpha = \frac{N_1}{N_2}$$

For shaft angles of more than 90 degrees:

$$\tan \alpha = \frac{\sin (180^\circ - \gamma)}{\frac{N_2}{N_1} - \cos (180^\circ - \gamma)}$$

For shaft angles of less than 90 degrees:

$$\tan \alpha = \frac{\sin \gamma}{\frac{N_2}{N_1} + \cos \gamma}$$

Having measured the outside diameter and found the center angle, we substitute these in the following formula:

$$P' = \frac{3.1416 \times O}{N + 2 \cos \alpha}$$

If the outside is so worn that we have to work from the root diameter, the following formula is used:

$$P' = \frac{3.1416 \times d}{N - 2.3142 \cos \alpha}$$

If necessary we can caliper to the hole, double the dimension and add the diameter of the hole for finding either the outside or the root diameters as already explained for the spur gears.

Worms and Wormwheels

In the case of a worm and wormwheel it is a simple matter to find the circular pitch, as it equals the distance from one worm thread to another in a line parallel with the axis of the worm. The lead equals the advance of one thread in one revolution. When the circular pitch and the outside diameter are known, then:

Pitch diam. of worm = outside diam − 0.6366 P'

Tangent of thread angle = $\frac{\text{lead} \times 0.3183}{\text{pitch diameter of worm}}$

In the case of a wormwheel, we should always determine the dimensions of the worm before starting to replace the gear, and should always know the center distance between the worm- and wheel-shafts, as the throat diameter of the wormwheel is seldom correct. The gear, therefore, should not be hobbed so as to get the same throat diameter as the sample worm-gear, but it should be hobbed with the hob corresponding to the mating worm at the correct center distance at which worm and wheel will run.

Spiral Gears

The following formulas may be used for finding the pitch diameter of spiral gears, when the outside or root diameter, the angle of the teeth with the axis of the gear, and the number of teeth are known. Let:

D = pitch diameter,
N = number of teeth,
α = angle of teeth with axis of gear,
O = measured outside diameter,
d = measured root diameter.

Then:

$$D = \frac{N \times O}{N + 2 \cos \alpha} = \frac{N \times d}{N - 2.3142 \cos \alpha}$$

The formulas given above are in all cases, of course, derived from the regular formulas for standard gears.

* * *

The following receipt for a non-shrinking alloy was recently published in the *Metal Industry*: Tin, 50 pounds, and zinc 50 pounds, gives a tough, hard metal that runs well. It is improved by the addition of 2 pounds of bismuth. By the use of heavy sprues, and by pouring cold, the slight shrinkage may be largely overcome.

PRIMITIVE BORING MACHINES

By JOSEPH G. HORNER*

In the French encyclopedia of D'Alembert and Diderot (1777) a drawing is shown of a machine for boring a cannon. (See Plate I.) A building with stone walls, supporting a single span ridge timber roof is provided with a central tower extending to a considerable height above the ridge. From horizontal beams *L* in this tower, pulley blocks *K* are hung, the lower blocks being attached to a sliding timber framing carrying the gun *H* to be bored, and sliding between vertical timber guides *Ff*, reaching from the floor up into the tower. These guides keep the gun to be bored in a fixed position in its framing throughout its vertical movements. It is suspended, mouth downwards over the boring tool, which is simply rotated. The feed is imparted to the gun as follows: The falls of the two ropes which come from the two upper blocks *K* of the suspended tackle are wound round a small drum

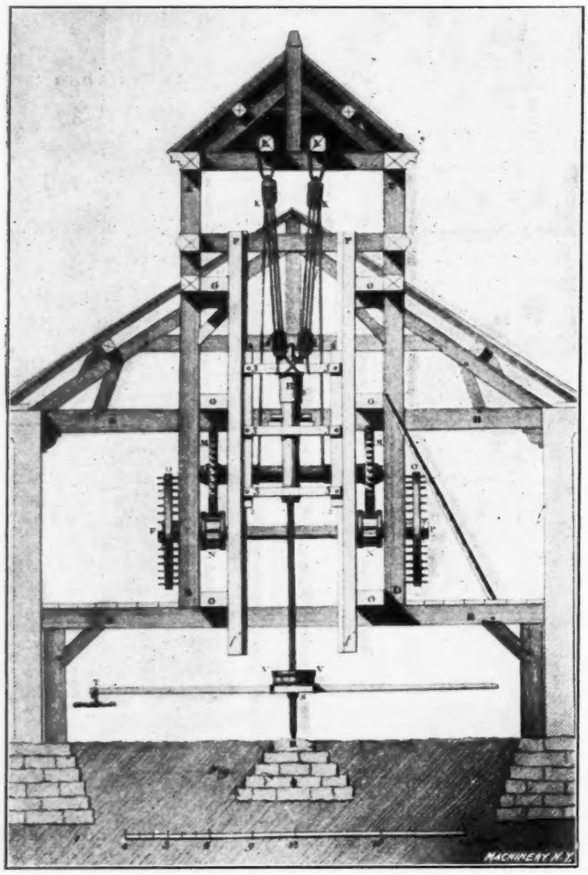


Plate I. A Gun Boring Machine of Large Proportions—Model of 1760

of several feet in length, the journals of which are carried in bearings on the uprights which carry the tower. The drum is rotated very slowly through two pairs of gears *M* and *N*, consisting of trundle pinions on a first motion shaft, and wooden cog-wheels on the drum shaft. The pinion shaft is turned by large wheels *O* on the shaft *P* with projecting pins arranged all around their peripheries. The down-feed of the gun in its sliding frame is thus controlled while boring.

The boring appliances are shown in detail in Plate II. Fig. 2 in this plate shows the vertical stem of the boring arbor broken off and carried up at *B*, and stepped into a bearing *R* below, which rests on masonry. It is rotated by a long lever with a loose handle seen at the right-hand end in Plate II, and at the left-hand end at *T* in Plate I, by which a workman or a horse pulls it around in a circle.

The remainder of the illustrations in Plate II show the boring tools, which are mostly reamers with inserted blades or milling cutters in embryo. Fig. 3 shows the boring tool *A*, having a four-sided tapered recess at *D* to fit over the end *b* of the arbor *B*. The end *A* is hemispherical, and is channeled. At the lower part of the plate the numbers 1, 4, 8, 12, 16 and 24 represent different bodies of copper which carry steel cutters to fit on the arbor *B*, the largest ones being used for finishing the bores. The tool No. 1 is used first, followed by the boring tool *A*, Fig. 3, after which the larger tools are used

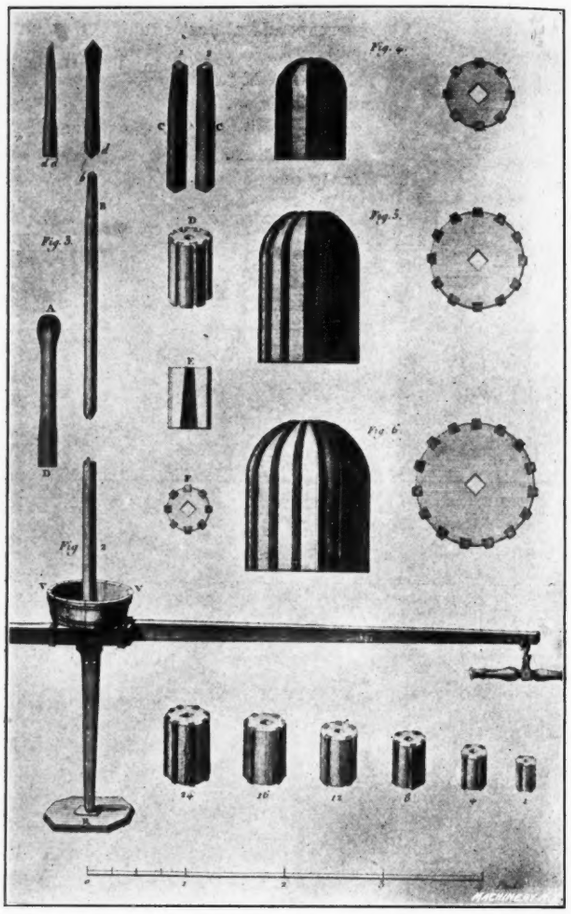


Plate II. Tools used for Boring Guns in France a Century and a Half ago

by which the diameter of the bore is gradually augmented until the boring is terminated. The details of tool 24 are shown above it; *F* is its plan, *E* its axial section, and *D* the

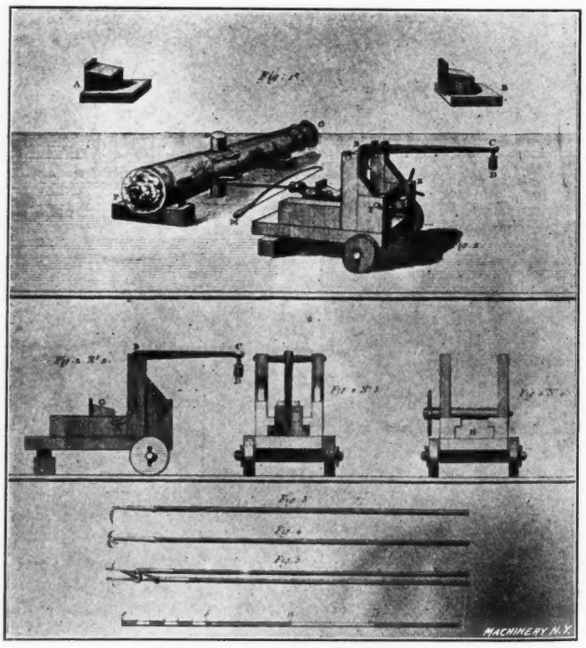


Plate III. A Portable Drilling and Boring Machine with Automatic Feed—Early French Type

body without its cutters. At *C* are seen two of the eight cutters drawn to a twice enlarged scale. The ends are bent, it is stated, for giving to the tool an opportunity to enter the bore.

Figs. 4, 5 and 6 illustrate boring tools for mortars of differ-

* Address: 45 Sydney Buildings, Bath, England.—See biographical note, MACHINERY, May, 1908.

ent calibers. The plan end views, showing the dovetailed setting of the cutters, are seen to the right.

The illustration at the top in Plate III shows the drilling of the touch holes in the cannon, and is an example of an early form of portable drill. The cannon which is being bored is supported on timber blocking, with wedge pieces, and the hole is being made with a fiddle drill, the bow being seen at *M*. The pressure against the drill is imparted by the lever *BC*, weighted at *D* as required. The block *G* takes the pressure of the pointed rear end of the drill. The shape of this block is seen at *A* and *B* above, giving front and rear views, the iron plate with its holes being shown at *B*. The axle *EF*, with a cross handle has a cord wound round it, the function of which is to withdraw the drill from the hole. In the middle view, Plate III, are shown side, front, and back views of the portable drilling frame.

NEW DESIGN OF HYDRAULIC CYLINDER GLANDS

By BENJAMIN BROWNSTEIN

The repacking of cylinders of large hydraulic presses of the type shown in Fig. 1 is not an easy and convenient matter, especially when the stroke is short and the cylinders large. The pressure on the rams of these presses ranges from 2000 pounds per square inch upward.

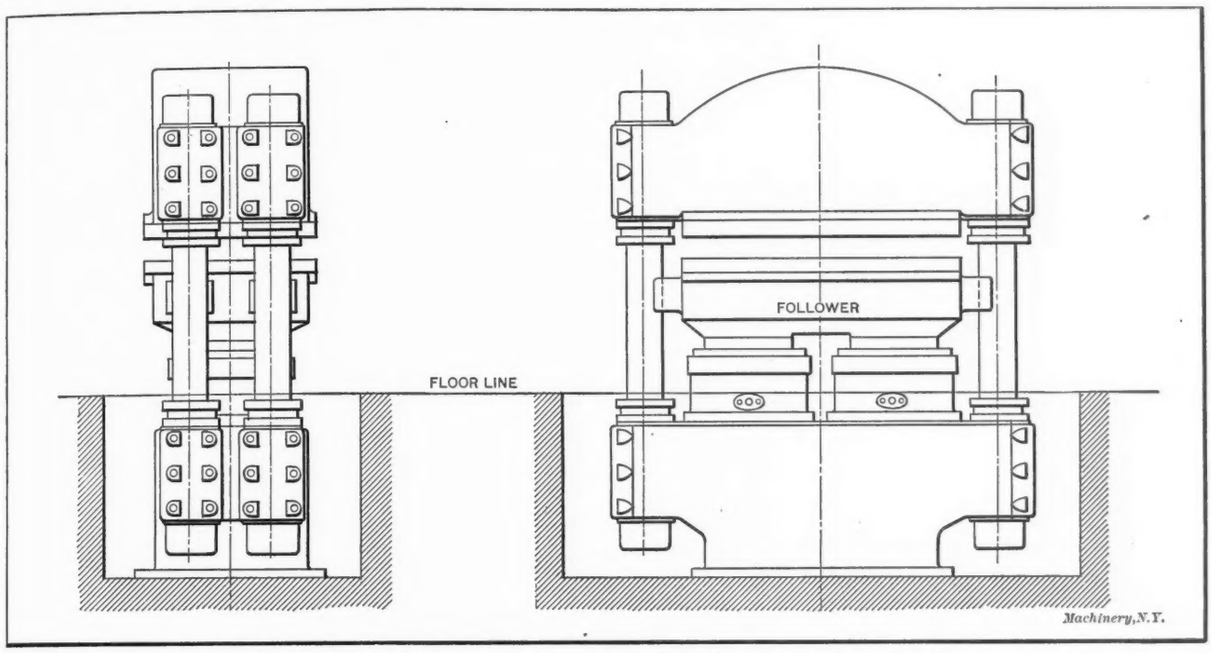


Fig. 1. Large Hydraulic Press of a Type Presenting Difficulties in Repacking the Cylinders

The usual design of the cylinder and gland is shown in Fig. 2. The gland is held down by a considerable number of studs and nuts which resist the upward pressure of the water acting on the packing at the bottom of the gland. When repacking this type of cylinder and gland, the follower is raised up from the rams and the nuts removed. This work is not very easily done, especially when the nuts are rusted

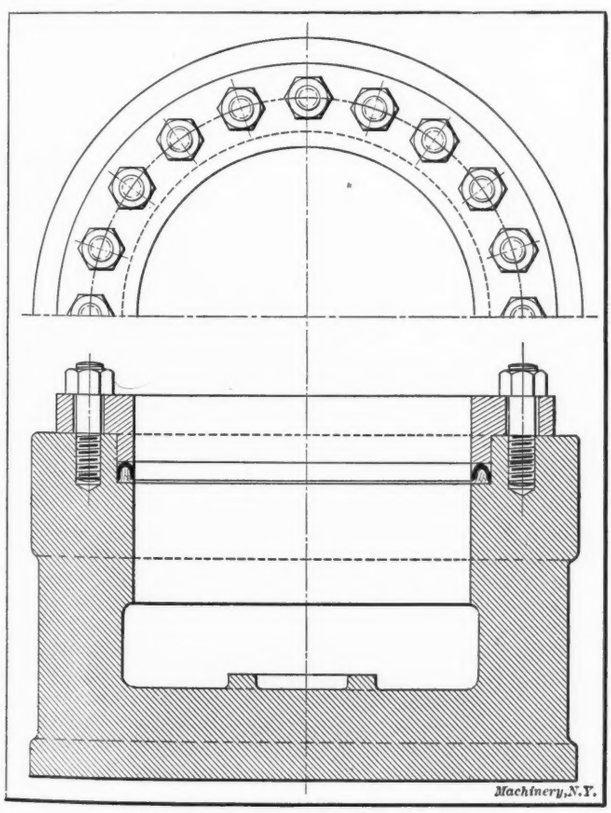


Fig. 2. Usual Design of Cylinder and Gland

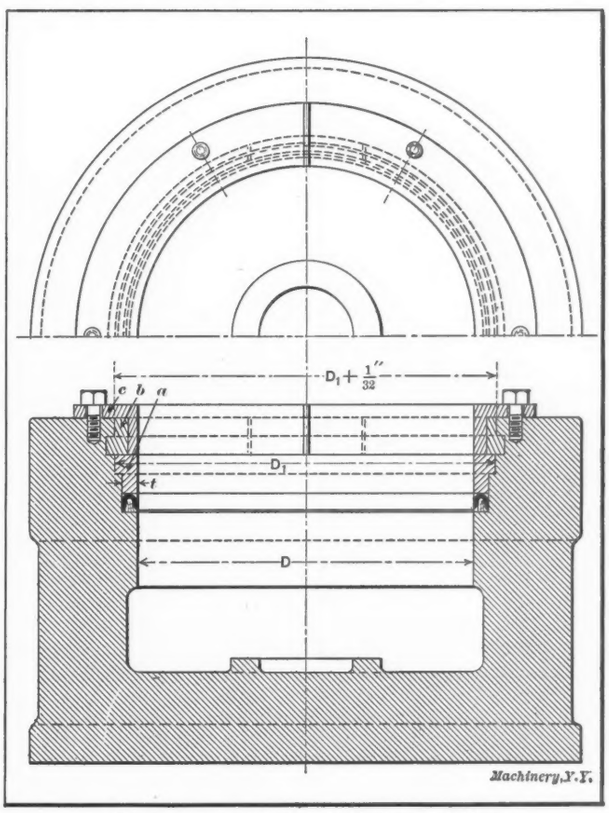


Fig. 3. Improved Design, Facilitating Repacking

in place, and when the space available prevents the use of a good-sized wrench. In many cases it is found more convenient to remove the cylinder with the ram and other parts from the press in order to repack it. Difficulty is also met with when replacing the gland and screwing the nuts home. If the nuts are not screwed down so that the tension on all the studs is equal, the load is thrown entirely upon those studs which are in greater tension.

The design of the hydraulic cylinder glands shown in Figs. 3 and 4 eliminates the troublesome studs and nuts; it allows the cylinder to be repacked without taking the press apart (the follower is simply raised up from the rams); it is stronger than the design with the greater number of studs,

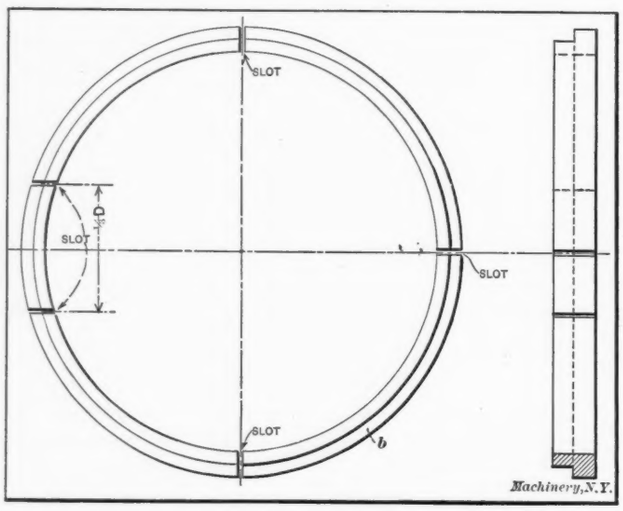


Fig. 4. Detail of Gland Bushing

as can be easily seen from studying the illustration Fig. 3, and is, therefore, capable of carrying a greater pressure and will give less trouble. In Fig. 3 is shown a section of the cylinder and cylinder gland. The gland is divided into three parts, *a* the bottom gland, *b* a gland bushing which is shown in detail in Fig. 4, and *c* the top gland. The bottom gland *a* is made solid and put in after the leather and hemp packing is inserted in its proper place. Then the gland bushing *b* is

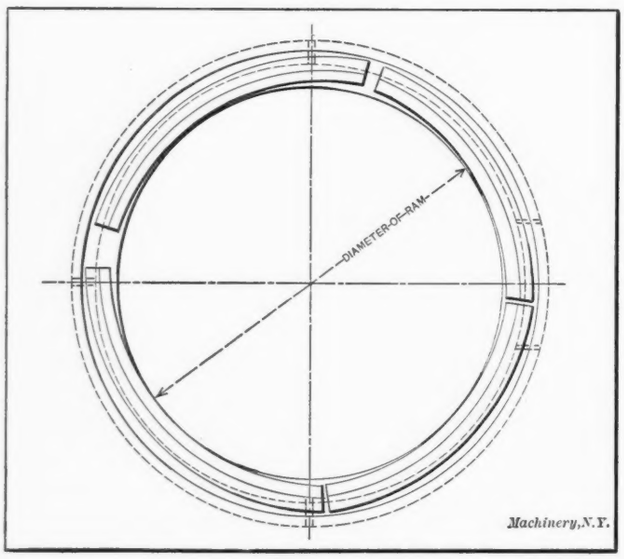


Fig. 5. Diagram showing how Bushing Sections can easily be removed and replaced

put into place. This bushing is made in five or more sections as shown in Fig. 4, according to the diameter of the cylinder and the thickness of the parts making up the gland. By making the bushing in this way the sections can easily be put in or taken out without removing the ram from the cylinder as will be apparent from a little study of the engraving Fig. 5.

The top gland *c* which is shown split but which can be made solid if the design of the press allows it, is then put into place and held down with two, four or six cap-screws or studs and nuts, as desired, the number of screws depending upon the size of the cylinder. It will be seen in Fig. 3 that this design of gland and cylinder eliminates the difficulties common to the general design shown in Fig. 2. This method of packing is superior in every way.

It is not possible to give all the proportions of the gland, as the most important factors, the diameter of the cylinder and the pressure per square inch are variable quantities, but the following may be stated as a general formula for calculating the stress on the gland.

Let P = pressure per square inch on ram,
t = thickness of bottom gland = width of packing,
P_1 = total pressure on gland a per inch of mean circumference,
S = safe shearing stress of flange of gland bushing b.

Then

$$P_1 = Pt, \text{ and } t = \frac{P_1}{S}.$$

* * *

AEROPLANE FLIGHT FROM LONDON TO MANCHESTER

A new record in aviation was established by Louis Paulhan, the French aviator, April 27 and 28, when making a flight from London to Manchester, England, and thereby winning a prize of $50,000 offered by the *Daily Mail*. According to the rules of the prize it was to be paid to the first aviator who traversed this distance of 185 miles, making only two stops and completing the journey in twenty-four hours. This is the greatest feat so far performed in aviation and is rewarded by the largest sum offered as an aviation prize. Mr. Paulhan started from London at 5.31 P. M., April 27, and continued in one uninterrupted flight as far as Litchfield, where he arrived at 8.10 P. M., after having covered 117 miles in two hours and thirty-nine minutes at an average speed of 44 miles per hour. From this point he resumed his journey at 4.9 A. M. the following morning, and arrived at Didsbury, near Manchester, at 5.30, completing the remaining 66 miles of the journey in 81 minutes at an average speed of 48.8 miles per hour. Mr. Paulhan competed with Mr. Grahame White, an Englishman, for this prize. Mr. White's efforts also deserve to be recorded. He started from London at 6.33 P. M. and stopped at Roade, 60 miles away at 7.55 P. M. In an effort to over-reach his rival he resumed his flight in the dark at 2.50 A. M., but had to again descend at 4.30 A. M. Starting again at 5.02 A. M. he found the wind conditions so adverse that he was compelled to descend at Litchfield at 5.20 A. M. for a second time.

Mr. Paulhan now holds both the long-distance record and the altitude record for aeroplanes. The week before his flight from London to Manchester he went a distance of 130 miles "cross-country" in France without alighting. At Los Angeles last January he won the altitude record for the heavier-than-air machines, rising to a height of 5000 feet.

* * *

ARTIFICIAL RUBBER

Dr. Carl Harries, professor of chemistry at the University of Kiel, Germany, has discovered a process of making artificial rubber. The product is said to have all the characteristics of natural rubber. The importance of the discovery to the automobile world can hardly be overestimated. The enormous consumption of rubber in the manufacture of tires has jumped to a price of $2.50 or more a pound, for pure Para rubber, from about 75 cents a pound less than two years ago. It is said that the artificial rubber is as tough and elastic as the natural product, and is a light brown to white in color. At present the manufacture is very costly, but it is expected that the process will be so simplified and cheapened as to produce the artificial rubber cheaper than the natural rubber. It is anticipated by some optimistic persons that the natural rubber industry will eventually suffer the same fate as that of the natural indigo industry. To-day artificial indigo, manufactured by German chemists, has virtually ousted the natural article from the market entirely.

THREADING OPERATIONS—2

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON*

The producing of a correct lobe on the cam for threading, and a knowledge of the various threading attachments and devices used, is essential, as was explained in the previous installment, but careful consideration should also be exercised in the selection of suitable dies and taps if good results are to be expected. The nature of the material to be threaded, of

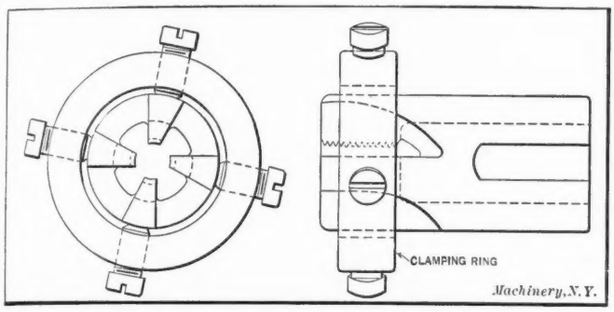


Fig. 11. Spring Screw Threading Die and Adjusting Ring

course, governs to a certain extent the particular design of die or tap to use. The various types of dies and taps, and die and tap holders, will be briefly reviewed.

Spring Screw Threading Dies

In Fig. 11 is shown a common form of spring screw threading die with its adjustable ring. Dies of this type are used to a large extent on the Brown & Sharpe automatics, but the results obtained are not always entirely satisfactory. There are a number of objections to this type of die, some of which are here given. The common method oof making these dies is to hob them out with a tap larger in diameter than the basic screw and then close them in by means of the

TABLE VI. ADJUSTABLE ROUND SPLIT SCREW THREAD BUTTON DIE SIZES FOR A. S. M. E. STANDARD SCREWS

Size of Screw and Number of Threads Per Inch	External Diameter	Pitch Diameter	Root Diameter
0.060 — 80	0.060	0.0519	0.0424
0.073 — 72	0.073	0.0640	0.0535
0.086 — 64	0.086	0.0759	0.0640
0.099 — 56	0.099	0.0874	0.0739
0.112 — 48	0.112	0.0985	0.0827
0.125 — 44	0.125	0.1102	0.0930
0.138 — 40	0.138	0.1218	0.1028
0.151 — 36	0.151	0.1330	0.1119
0.164 — 36	0.164	0.1460	0.1249
0.177 — 32	0.177	0.1567	0.1330
0.190 — 30	0.190	0.1684	0.1431
0.216 — 28	0.216	0.1928	0.1658
0.242 — 24	0.242	0.2149	0.1834
0.268 — 22	0.268	0.2385	0.2040
0.294 — 20	0.294	0.2615	0.2236
0.320 — 20	0.320	0.2875	0.2496
0.346 — 18	0.346	0.3099	0.2678
0.372 — 16	0.372	0.3314	0.2841
0.398 — 16	0.398	0.3574	0.3101
0.424 — 14	0.424	0.3776	0.3235
0.450 — 14	0.450	0.4036	0.3495

adjusting ring shown. This produces an imperfect thread if a tap much larger in diameter than the basic size of the screw is used. The correct method of tapping out a die of this kind is to use a taper tap which gives clearance at the back of the die, as is necessary. This necessitates the making of taper taps, as can be easily seen, which adds to the expense of the die. This type of die is also difficult to harden without springing the prongs, thus causing chattering and producing a thread which is not spherical in shape. Making a die with three prongs or cutting edges obviates chattering and produces a more nearly perfect thread. When cutting a small screw, the work sometimes breaks off in the die, leaving it practically useless, because in drilling the broken pieces out, the thread in the die is sacrificed in most cases. A type of die which overcomes this latter objection is shown in Fig. 12, the die here shown being split, allowing the broken screw to be easily removed. The location of the cutting edges on spring screw threading dies should be radial for brass, and about 0.1 of the diameter ahead of the center for Norway iron, machine steel, etc.

*Associate Editor of MACHINERY.

Adjustable Round Split Screw Threading Dies

This form of die has an advantage over the spring screw threading die for the following reasons: It can be hardened without springing out of shape, and can be held more rigidly, which produces good results; and although it cannot be ground to advantage, its first cost is so much less that it can be discarded when dull. On account of the rigid manner in which this die can be held, the cutting edges in all cases can be located ahead of the center about 0.1 of the diameter which gives good results. An improved method of laying out button dies was described in the March, 1909, issue of MACHINERY.

TABLE VII. ADJUSTABLE ROUND SPLIT SCREW THREAD BUTTON DIE SIZES FOR A. S. M. E. SPECIAL SCREWS

Size of Screw and Number of Threads Per Inch	External Diameter	Pitch Diameter	Root Diameter
0.073 — 64	0.073	0.0629	0.0510
0.086 — 56	0.086	0.0744	0.0609
0.099 — 48	0.099	0.0855	0.0697
0.112 — 40	0.112	0.0958	0.0768
0.112 — 36	0.112	0.0940	0.0729
0.125 — 40	0.125	0.1088	0.0898
0.125 — 36	0.125	0.1070	0.0859
0.138 — 36	0.138	0.1200	0.0989
0.138 — 32	0.138	0.1177	0.0940
0.151 — 32	0.151	0.1307	0.1070
0.151 — 30	0.151	0.1294	0.1041
0.164 — 32	0.164	0.1437	0.1200
0.164 — 30	0.164	0.1424	0.1171
0.177 — 30	0.177	0.1554	0.1301
0.177 — 24	0.177	0.1499	0.1184
0.190 — 32	0.190	0.1697	0.1460
0.190 — 24	0.190	0.1629	0.1314
0.216 — 24	0.216	0.1889	0.1574
0.242 — 20	0.242	0.2095	0.1716
0.268 — 20	0.268	0.2355	0.1976
0.294 — 18	0.294	0.2579	0.2158
0.320 — 18	0.320	0.2839	0.2418
0.346 — 16	0.346	0.3054	0.2581
0.372 — 18	0.372	0.3359	0.2938
0.398 — 14	0.398	0.3516	0.2975
0.424 — 16	0.424	0.3834	0.3361
0.450 — 16	0.450	0.4094	0.3621

In Fig. 13 is shown a type of adjustable round split button die as used by the Northern Electric & Mfg. Co., Ltd., of Montreal. This type of die has been found to give such favorable results that it is used by this firm in preference to all the other types for screw machine work. In Tables VI and VII are given the sizes as used by the above firm in making their

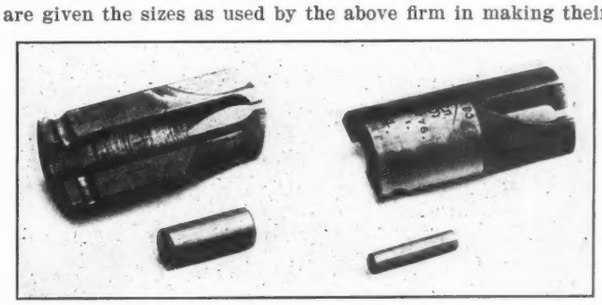


Fig. 12. Split Spring Screw Threading Die

dies for the A. S. M. E. standard and special screw sizes. The formulas used for the dies are as follows:

External diameter = basic external diameter of screw,

Pitch diameter = basic pitch diameter of screw,

$$\text{Root diameter} = \text{basic root diameter of screw} + \frac{0.10825}{T.P.I.}.$$

This latter amount $\frac{0.10825}{T.P.I.}$ is added to the basic root di-

ameter to provide for wear. While the sizes as given have been used by the firm mentioned, for a considerable time, theoretically it is not the correct way of making the die, because, to cut a clean thread, a die should have clearance as shown at *a*, Fig. 14, and as a screw is generally cut below the maximum diameter, the sizes as given would not provide any clearance at all; in fact it would be just the reverse, as the die would have to be closed, instead of opened up. The writer would suggest that when good results are desired the die should be tapped out smaller than the basic screw, and then opened up, as this would give a good clearance as shown enlarged for clearness at *a*, Fig. 14. Making the root diameter of the die the same as the minimum screw would give the desired results. This has been experimented with and the results obtained were perfectly satisfactory. The following formulas should be used for obtaining the sizes of adjustable round split button dies:

External diameter = basic external diameter of screw,

Pitch diameter = minimum pitch diameter of screw, or

$$\text{basic pitch diameter of screw} - \frac{0.168}{T.P.I.+40},$$

Root diameter = minimum root diameter of screw or basic

$$\text{root diameter} - \left(\frac{0.10825}{T.P.I.} + \frac{0.168}{T.P.I.+40}\right)$$

Making the external diameter equal to the basic external diameter allows for clearance, which is necessary, as the external diameter of the die should not be used for cutting the screw to size. This should be accomplished either by a finishing box-tool or by the cross-slide forming tools. It is obvious that making the dies to the sizes given in the formulas permits them to be used longer and still cut a clean thread. The work should be turned slightly smaller than the finish diameter required, depending on the material and the pitch of the thread.

TABLE VIII. MACHINE TAPS FOR A. S. M. E. STANDARD SIZES

Size of Screw and Number of Threads Per Inch	Manufacturing Limits						Diameter of Shank, Stubbs' Wire Gage or Inches	Length of Threaded Portion	Length Overall
	External Diameter		Pitch Diameter		Root Diameter				
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum			
0.060 — 80	0.0632	0.0623	0.0538	0.0533	0.0466	0.0447	51	3/8	1 1/4
0.073 — 72	0.0765	0.0755	0.0660	0.0655	0.0580	0.0560	47	1/2	1 3/8
0.086 — 64	0.0898	0.0888	0.0780	0.0775	0.0689	0.0668	42	9/16	1 3/8
0.099 — 56	0.1033	0.1021	0.0897	0.0892	0.0793	0.0770	36	9/16	1 1/2
0.112 — 48	0.1168	0.1155	0.1010	0.1004	0.0888	0.0862	31	5/8	1 1/2
0.125 — 44	0.1301	0.1288	0.1129	0.1122	0.0995	0.0968	29	5/8	1 1/2
0.138 — 40	0.1435	0.1421	0.1246	0.1239	0.1097	0.1069	26	5/8	1 1/2
0.151 — 36	0.1569	0.1555	0.1359	0.1352	0.1193	0.1164	21	11/16	1 1/2
0.164 — 36	0.1699	0.1685	0.1489	0.1482	0.1323	0.1294	17	11/16	1 1/2
0.177 — 32	0.1835	0.1819	0.1598	0.1590	0.1411	0.1380	12	3/4	1 5/8
0.190 — 30	0.1968	0.1952	0.1716	0.1708	0.1515	0.1483	8	3/4	1 5/8
0.216 — 28	0.2232	0.2215	0.1961	0.1953	0.1745	0.1712	1/4	1	2 1/2
0.242 — 24	0.2500	0.2483	0.2184	0.2176	0.1931	0.1896	9/32	1	2 1/2
0.268 — 22	0.2765	0.2747	0.2421	0.2412	0.2144	0.2108	9/32	1	2 1/2
0.294 — 20	0.3031	0.3013	0.2653	0.2643	0.2346	0.2309	5/16	1	2 1/2
0.320 — 20	0.3291	0.3273	0.2913	0.2903	0.2606	0.2569	11/32	1	2 3/4
0.346 — 18	0.3559	0.3539	0.3138	0.3128	0.2796	0.2758	3/8	1	2 3/4
0.372 — 16	0.3828	0.3808	0.3354	0.3344	0.2968	0.2928	13/32	1	2 3/4
0.398 — 16	0.4088	0.4068	0.3614	0.3604	0.3228	0.3188	7/16	1	2 3/4
0.424 — 14	0.4359	0.4338	0.3818	0.3807	0.3374	0.3333	15/32	1	2 3/4
0.450 — 14	0.4619	0.4598	0.4078	0.4067	0.3634	0.3593	1/2	1	2 3/4

TABLE IX. MACHINE TAPS FOR A. S. M. E. SPECIAL SIZES

Size of Screw and Number of Threads Per Inch	Manufacturing Limits						Diameter of Shank, Stubbs' Wire Gage or Inches	Length of Threaded Portion	Length Overall
	External Diameter		Pitch Diameter		Root Diameter				
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum			
0.073 — 64	0.0768	0.0758	0.0650	0.0645	0.0559	0.0538	47	1/2	1 3/8
0.086 — 56	0.0903	0.0891	0.0767	0.0762	0.0663	0.0640	42	9/16	1 3/8
0.099 — 48	0.1038	0.1025	0.0880	0.0874	0.0758	0.0732	36	9/16	1 1/2
0.112 — 40	0.1175	0.1161	0.0986	0.0979	0.0837	0.0809	31	5/8	1 1/2
0.112 — 36	0.1179	0.1165	0.0969	0.0962	0.0803	0.0774	31	5/8	1 1/2
0.125 — 40	0.1305	0.1291	0.1116	0.1109	0.0967	0.0939	29	5/8	1 1/2
0.125 — 36	0.1309	0.1295	0.1099	0.1092	0.0933	0.0904	29	5/8	1 1/2
0.138 — 36	0.1439	0.1425	0.1229	0.1222	0.1063	0.1034	26	5/8	1 1/2
0.138 — 32	0.1445	0.1429	0.1208	0.1200	0.1021	0.0990	26	5/8	1 1/2
0.151 — 32	0.1575	0.1559	0.1338	0.1330	0.1151	0.1120	20	11/16	1 1/2
0.151 — 30	0.1578	0.1562	0.1326	0.1318	0.1125	0.1093	20	11/16	1 1/2
0.164 — 32	0.1705	0.1689	0.1468	0.1460	0.1281	0.1250	17	11/16	1 1/2
0.164 — 30	0.1708	0.1692	0.1456	0.1448	0.1255	0.1223	17	11/16	1 1/2
0.177 — 30	0.1838	0.1822	0.1586	0.1578	0.1385	0.1353	12	3/4	1 5/8
0.177 — 24	0.1850	0.1833	0.1534	0.1526	0.1281	0.1246	12	3/4	1 5/8
0.190 — 32	0.1965	0.1949	0.1728	0.1720	0.1541	0.1510	8	3/4	1 5/8
0.190 — 24	0.1980	0.1963	0.1664	0.1656	0.1411	0.1376	7	3/4	1 5/8
0.216 — 24	0.2240	0.2223	0.1924	0.1916	0.1671	0.1636	1/4	1	2 1/2
0.242 — 20	0.2511	0.2493	0.2133	0.2123	0.1827	0.1789	9/32	1	2 1/2
0.268 — 20	0.2771	0.2753	0.2393	0.2383	0.2087	0.2049	9/32	1	2 1/2
0.294 — 18	0.3039	0.3019	0.2618	0.2608	0.2276	0.2238	5/16	1	2 1/2
0.320 — 18	0.3299	0.3279	0.2878	0.2868	0.2536	0.2498	11/32	1	2 3/4
0.346 — 16	0.3568	0.3548	0.3094	0.3084	0.2708	0.2668	3/8	1	2 3/4
0.372 — 18	0.3819	0.3799	0.3398	0.3388	0.3056	0.3018	13/32	1	2 3/4
0.398 — 14	0.4099	0.4078	0.3558	0.3547	0.3114	0.3073	7/16	1	2 3/4
0.424 — 16	0.4348	0.4328	0.3874	0.3864	0.3488	0.3448	15/32	1	2 3/4
0.450 — 16	0.4608	0.4588	0.4134	0.4124	0.3748	0.3708	1/2	1	2 3/4

Machine Taps

Internal threading is more difficult to accomplish than external threading on the automatic; the reason for this is, of course, that the tap, when it once enters the work, cannot be reversed to relieve the clogging of the chips, as can be done in hand tapping. The spindle also, revolving at a high rate of speed, has a tendency to break the tap—it is at this point that the tap generally breaks, as the chips lodging in the flutes of the tap prevent it from reversing. For this reason the land should be just strong enough to resist the cutting pressure, leaving plenty of chip space without reducing the cross-section of the tap too much. The flutes in the tap are generally cut radially with the center, and slightly deeper than the root of the thread, the amount, of course, varying according to the diameter of the tap and the pitch of the thread. For brass work the ordinary tap is generally used with the teeth cut radially with the center. In Tables VIII and IX are given the manufacturing limits, as adopted by the Northern Electric & Mfg. Co., Ltd., Montreal, for the A. S. M. E. standard and special sizes. The taps are made from Stubbs' imported drill rod. The diameters of shank used are given in the tables, and also the length of the threaded portion and the over-all length. All taps 0.100 inch diameter and less have three flutes, and all taps over 0.100 inch diameter have four flutes. The formulas used by the above firm for the manufacturing limits are as follows:

TABLE X. FORMULAS FOR FINDING MANUFACTURING LIMITS FOR TAP AND DIE SIZES

No. of Threads Per Inch	Value of $\frac{0.10825''}{T.P.I.}$	Value of $\frac{0.112''}{T.P.I.+40}$	Value of $\frac{0.224'}{T.P.I.+40}$	Value of $\frac{0.336''}{T.P.I.+40}$	Value of $\frac{0.168''}{T.P.I.+40}$	Value of $\frac{0.64952''}{T.P.I.}$	Value of $\frac{1.9904''}{T.P.I}$
80	0.0014	0.0009	0.0019	0.0028	0.0014	0.0081	0.0162
72	0.0015	0.0010	0.0020	0.0030	0.0015	0.0090	0.0180
64	0.0017	0.0011	0.0022	0.0032	0.0016	0.0101	0.0203
56	0.0019	0.0012	0.0023	0.0035	0.0018	0.0116	0.0232
48	0.0023	0.0013	0.0025	0.0038	0.0019	0.0135	0.0271
44	0.0025	0.0013	0.0027	0.0040	0.0020	0.0148	0.0295
40	0.0027	0.0014	0.0028	0.0042	0.0021	0.0162	0.0325
36	0.0030	0.0015	0.0029	0.0044	0.0022	0.0180	0.0361
32	0.0034	0.0016	0.0031	0.0047	0.0023	0.0203	0.0406
30	0.0036	0.0016	0.0032	0.0048	0.0024	0.0217	0.0433
28	0.0039	0.0016	0.0033	0.0049	0.0025	0.0232	0.0464
24	0.0045	0.0018	0.0035	0.0053	0.0026	0.0271	0.0541
22	0.0049	0.0018	0.0036	0.0054	0.0027	0.0295	0.0590
20	0.0054	0.0019	0.0037	0.0056	0.0028	0.0325	0.0650
18	0.0060	0.0019	0.0039	0.0058	0.0029	0.0361	0.0722
16	0.0068	0.0020	0.0040	0.0060	0.0030	0.0406	0.0812
14	0.0077	0.0021	0.0041	0.0062	0.0031	0.0464	0.0928

External diameter

$$\text{Maximum} = \text{basic external diameter of screw} + \left(\frac{0.10825}{T.P.I.} + \frac{0.224}{T.P.I.+40}\right)$$

$$\text{Minimum} = \text{basic external diameter of screw} + \left(\frac{0.10825}{T.P.I.} + \frac{0.112}{T.P.I.+40}\right)$$

Pitch diameter

$$\text{Maximum} = \text{basic pitch diameter of screw} + \frac{0.224}{T.P.I. + 40}$$

$$\text{Minimum} = \text{basic pitch diameter of screw} + \frac{0.168}{T.P.I. + 40}$$

Root diameter

$$\text{Maximum} = \text{basic root diameter of screw} + \frac{0.336}{T.P.I. + 40}$$

$$\text{Minimum} = \text{basic root diameter of screw} + \frac{0.112}{T.P.I. + 40}$$

The only changes from the A. S. M. E. formulas (see MACHINERY, December, 1907) for the taps are the minimum external diameter, and the minimum pitch diameters. The reason for increasing the minimum external diameters can easily be seen by comparing the results as obtained by the formulas used by the Northern Electric & Mfg. Co. and the A. S. M. E. respectively. For example: Take a tap 0.164—36 pitch. The minimum external diameter given by the A. S. M. E. is 0.1656 inch. Now the maximum or basic screw is 0.164 inch. This leaves 0.0016 inch for wear, when the tap has been made the minimum size. This amount has been found not to be sufficient. The minimum external diameter, as found by the formula used by the Northern Electric & Mfg. Co., is 0.1685 inch, which gives 0.0045 inch over the basic screw. As will also be noted, this decreases the limit between the maximum and minimum external diameters of the tap, allowing only 0.0014 inch. In all cases the limits as derived by these formulas have been found to be sufficient. It will also be noted that the minimum pitch diameter is also increased to extend the life of the tap. In Table X the results as obtained by the various formulas are given, which simplifies the calculations necessary in determining the limits, as the amounts given are added to the basic sizes of the screw. In the last two columns are given the single and double depth of the thread. As has previously been mentioned, an ordinary machine tap is suitable for cutting brass, but it does not give satisfactory results when tapping Norway iron, machine steel, etc. In Fig. 15 is shown a tap which gives good results in threading Norway iron or machine steel. This tap should be slightly tapered towards the back for clearance,

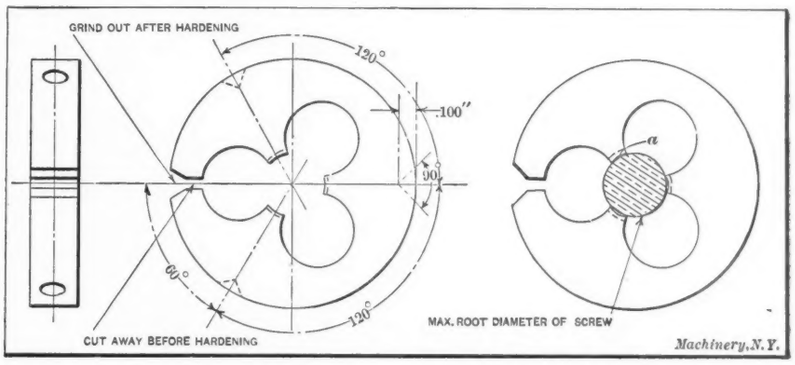


Fig. 13. Adjustable Round Split Button Die

Fig. 14. Illustration showing Clearance for Adjustable Round Split Button Dies

and also to eliminate friction. The end is ground at an angle of about 55 degrees, and slightly cupped at the center, and backed off as shown. A groove, as shown, is ground the entire length of the threaded portion, after the tap has been hardened. This allows the oil to penetrate to the point in threading, and also provides clearance for the chips to back out. When made from Stubbs' imported drill rod and carefully hardened, this tap can be worked at from 35 to 40 surface feet per minute, which would be impossible with an ordinary tap. Taps for threading copper have their flutes cut spirally

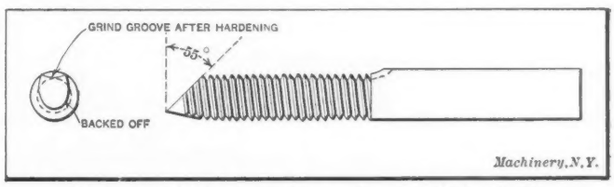


Fig. 15. A Suitable Tap for Norway Iron and Machine Steel

and should also have an odd number of flutes. A right-hand spiral about one turn in 12 inches should be used.

Tapping Drills

The tapping size drills as recommended by the A. S. M. E. are not suitable for general work, as I presume many who have experimented with them have learned to their sorrow. The question of tapping drills cannot be settled by giving a table and saying that the sizes therein contained are the best.

Of course, to a certain extent, the sizes used in various shops do not vary greatly, but nevertheless there is really no standard size. Considering this the writer submits a list of tapping size drills which have been adopted by the Northern Electric & Mfg. Co. for general work. These sizes have given good results in practice. The sizes as given in Table XI are used for all classes of work and material. The amount of thread obtained by these sizes is from 5/8 to 3/4 of a full thread.

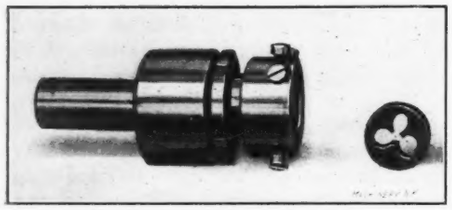


Fig. 16. Button Die Holder of the Draw-out Type

Speeds for Dies and Taps

As a general rule, a die can be operated at a higher rate of speed than a tap, for the following reasons: A die can be left harder than a tap on account of the weak cross-section of the tap, and as the tap is easier to re-sharpen, it can therefore, be left softer. Another reason is that the die can be supplied with oil much easier than can the tap. The following surface speeds have been found suitable for taps and dies made from ordinary carbon steel and used on the materials specified:

TABLE XI. TAP DRILLS FOR A. S. M. E. STANDARD AND SPECIAL MACHINE SCREWS

Special sizes are marked *

Size of Screw and Number of Threads Per Inch	Size of Tap Drill	Decimal Equivalent of Tap Drill	Size of Screw and Number of Threads Per Inch	Size of Tap Drill	Decimal Equivalent of Tap Drill
0.060—80	56	0.0465	*0.177—24	27	0.1440
0.073—72	53	0.0595	*0.190—32	19	0.1660
*0.073—64	53	0.0595	0.190—30	20	0.1610
0.086—64	49	0.0730	*0.190—24	21	0.1590
*0.086—56	50	0.0700	0.216—28	13	0.1850
0.099—56	45	0.0820	*0.216—24	14	0.1820
*0.099—48	46	0.0810	0.242—24	5	0.2055
0.112—48	42	0.0935	*0.242—20	7	0.2010
*0.112—40	43	0.0890	0.268—22	1	0.2280
*0.112—36	43	0.0890	*0.268—20	1	0.2280
0.125—44	37	0.1040	0.294—20	1/4	0.2500
*0.125—40	37	0.1040	*0.294—18	1/4	0.2500
*0.125—36	38	0.1015	0.320—20	J	0.2770
0.138—40	32	0.1160	*0.320—18	J	0.2770
*0.138—36	33	0.1130	0.346—18	19/64	0.2968
*0.138—32	32	0.1160	*0.346—16	19/64	0.2968
0.151—36	30	0.1285	*0.372—18	21/64	0.3281
*0.151—32	1/8	0.1250	0.372—16	P	0.3230
*0.151—30	1/8	0.1250	0.398—16	11/32	0.3437
0.164—36	28	0.1405	*0.398—14	11/32	0.3437
*0.164—32	28	0.1405	*0.424—16	3/8	0.3750
*0.164—30	28	0.1405	0.424—14	U	0.3680
0.177—32	24	0.1520	*0.450—16	13/32	0.4062
*0.177—30	24	0.1520	0.450—14	25/64	0.3906

Surface Speeds for Dies

Material	Feet per Minute
Brass (ordinary quality)	190-200
Norway iron and machine steel	30-40
Drill rod and tool steel	20-30

Surface Speeds for Taps

Material	Feet per Minute
Brass (ordinary quality)	150-160
Norway iron and machine steel	25-30
Drill rod and tool steel	15-20

When the diameter of the tap and the surface feet per minute are given, the revolutions of the spindle can be found by the following formula:

$$R = \frac{12 \times S}{D \times \pi}$$

where R = revolutions of the spindle,
S = surface feet per minute,
D = external diameter of tap or die.

When the surface speed and diameters are required the formula takes the following forms:

$$S = \frac{\pi \times D \times R}{12} \quad \text{or} \quad D = \frac{S \times 12}{R \times \pi}$$

Die and Tap Holders

The manner in which a die or tap is held when being applied to the work has a considerable bearing on the results obtained. For this reason careful consideration should be exercised when deciding on the type of die or tap holder to be used. The die or tap holders as supplied by the Brown & Sharpe Mfg. Co. give satisfactory results in most cases, and, therefore, the writer would suggest that for general automatic work these holders should be used. In Fig. 16 is shown a button die holder of the draw-out type, as made by the above firm. This holder gives good results when the work is not required to be threaded up to a shoulder. In Fig. 17 is shown an improved design of releasing button die holder also made by this firm, a section through the holder being shown at *A*. The main feature of this die holder is that it can be reversed without shock; therefore, when threading small screws it has less tendency to break the screw off in the die. At *B* and *C* are shown two views taken from the cross-section *X Y*. At *B* and *C* are also shown two small balls *e* which are used, allowing this die holder to reverse without shock. The operation of this die holder is as follows: When the die holder or spindle *a* draws out from the body *b*, the driving pins *c* are also withdrawn so that the radius on the end of these pins is drawn out flush with the plate *m*. Thus when the machine spindle is reversed the spindle *a* revolves with the work, the centrifugal force throwing the ball *e* out of the deep part of the pocket as shown at *B* into the position as shown at *C*. This locks the holder, allowing it to be backed off the work. This holder can be used either for right- or

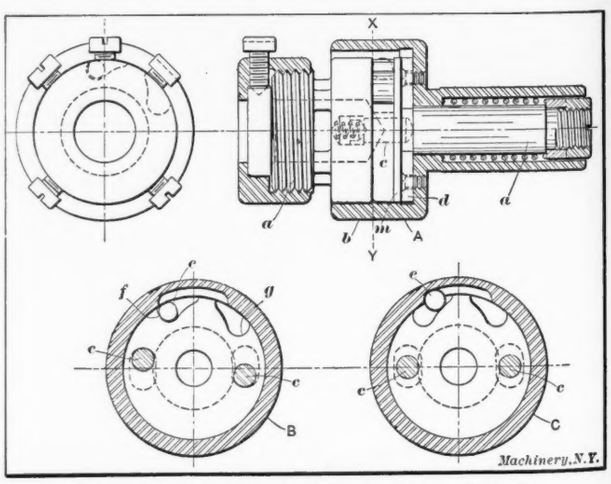


Fig. 17. Illustration showing Operating Parts of Releasing Button Die Holder

left-hand threading simply by inserting the balls *e* in the various pockets, *e. g.*, when ball *e* is placed in pocket *f* it will cut a right-hand thread, and when placed in pocket *g* it will cut a left-hand thread. This holder is used to advantage especially when cutting up to a shoulder. In Fig. 18 is shown a releasing tap holder. The spindle *A* carries a pawl *a*, which is held back against the shoulder *C* by the spring *b*. When the spindle *A* draws out, the bevel portion on the pawl *a* allows it to slide past the block *B*, thus allowing the spindle *A* to make one revolution when the opposite face of pawl *b* comes in contact with the block *B*, thus allowing the tap to back out of the work. A blank bushing *d* is shown in the holder.

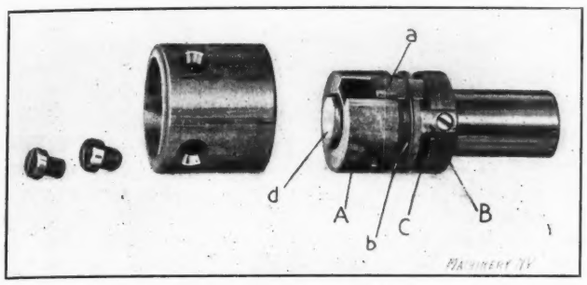


Fig. 18. Releasing Tap Holder

Using Two Taps

When a full thread is desired and the size of the tap will not stand the cutting pressure, it is sometimes found convenient to use two taps. The first tap should be ground tapered somewhat similar to a starting tap which is used for hand tapping. The taper should extend back equal to the distance that the tap is to go into the work so that the first thread left in the work will be to the full diameter. The second tap is left with a full thread. To set the taps, the dogs on the drum should be set so that the spindle will be reversing at about the same point on both the thread lobes. Then the first tap is set and made to travel into the work the desired distance. The second tap is then set in the turret, the distance from the face of the turret being the same as for the first tap. If this procedure is followed, little difficulty will be encountered. A reversing tap holder as shown in Fig. 18 is preferable to the draw-out type for this purpose, as the taps are not required to be set as accurately.

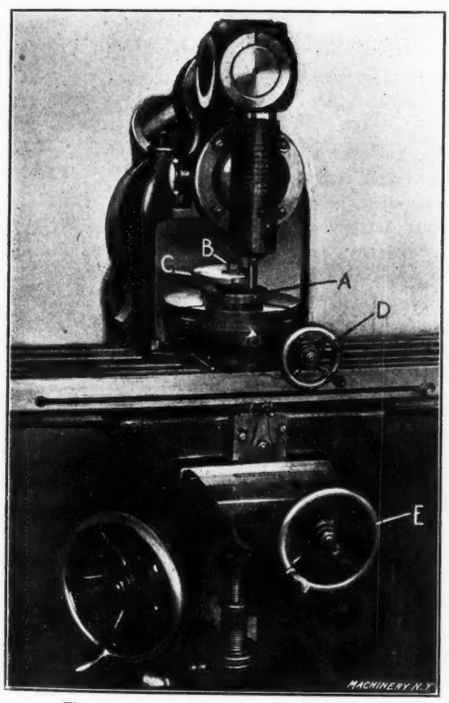


Fig. 19. Cutting Thread Lobe on a Circular Milling Attachment

Cutting the Thread Lobe

In Fig. 19 is shown the circular milling attachment (mentioned in the previous installment of this article) in position on the Brown & Sharpe universal milling machine, which is equipped with the vertical milling attachment. Before cutting the cam the various lobes are laid out in their respective positions as designated on the drawing, and the superfluous metal is removed either by shearing in a punch press or by drilling a series of 3/16-inch holes about 1/16-inch from the outline of the various lobes. The cam is then placed on block *A*, as shown, which has a projecting stud, nut *B* being used to hold the cam down tight against the face of this block. The block is held to the circular milling attachment by two screws not shown in the illustration. To cut the cam, raise the knee until the end mill passes the lower face of the cam *C* as shown and bring the end mill into position at the bottom of the lobe, in other words, at the point where the die would start on the work. Then feed the end mill in the desired distance. The micrometer collars on the shafts carrying the handles *D* and *E* are then set at zero. Referring to Fig. 10, which was given in the previous installment of this article, we find that the lead on the lobe is one thousandth inch for each 3½ minutes of its circumference, but the smallest division on this attachment is five minutes. We will, therefore, revolve the attachment five minutes for each 0.00175 inch that we feed the cam in, continuing in this manner until that side of the lobe is finished. The attachment is then swung around and the other side of the lobe completed in the same manner. Milling the cam in this manner leaves a series of slight flats on the lobe which can be removed by filing, giving the cam lobe an approximately true curve.

* * *

REMOVAL OF CHIPS WHEN REAMING

By T. COVEY

Jim, the apprentice boy, started one morning to fasten some angle-plates onto some castings that were to be used as jigs, and it was not desirable to have the screw and dowel-pin holes go through both pieces; in other words they were "blind" holes. He had been instructed to drill the screw holes first, making the holes in the angle-plate a little larger than the screws that went through them so that the plate could be shifted slightly. Then, to set the plates accurately where they are wanted, clamp them fast with their own screws, and then drill and ream dowel-pin holes through the angle-plates into the casting. He was busy reaming these dowel-pin holes, and in order to get the reamer to go clear down to the bottom found it necessary to frequently remove it and clean out the chips, which was very troublesome on account of the necessity of using oil. A toolmaker who was going to finish the jigs, being about ready to start work on one of them, came up to see how he was progressing. "You seem to like to probe around in that hole with that little flattened wire," said he. "What is the object?"

"How do you suppose I can get a reamer into a hole that is half full of chips," said Jim; "if they were dry I could blow them out with this little bent pipe, but oily ones don't blow worth a cent."

"If you were to fill that hole you have just reamed full of oil and force the reamer down into it quickly, what would be the result?"

"Why, the oil would squirt up the sides of the reamer I suppose."

"Exactly! Now if you were to fill one of the holes that you haven't reamed full of oil and were to go ahead and ream it, the result would be the same; that is, the oil underneath the reamer would be forced up along the sides of the reamer just the same only not so fast; still it would be plenty fast enough to carry the chips out as fast as the reamer made them. Try one and see how it works—only after you start the reamer down, keep it going down; if you lift it up the oil will be sucked into the hole and the chips with it where they would soon settle to the bottom."

"Say, that works all right," said Jim.

"Yes, with large holes though, that would not be a very profitable way to use oil; but then with large holes it is easy to get the chips out, so it is not necessary."

* * *

According to an estimate by the *Elektrotechnische Zeitschrift* the actual available water power on the European continent, after deductions have been made for water power which cannot be commercially exploited, is about 36,000,000 horsepower. Of this more than 14,000,000 horsepower is available in Sweden and Norway, 6,000,000 horsepower in Austria-Hungary, and in France and Italy about 5,500,000 horsepower each.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION

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JULY, 1910

PAID CIRCULATION FOR JUNE, 1910, 26,617 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

Ralph E. Flanders, for five years an associate editor of MACHINERY, has resigned to return to practical work, a change which he has long desired to make, and which deprives trade journalism of one of its ablest writers. Mr. Flanders is a mechanic of wide practical knowledge, and an all-around fine fellow whom it was a pleasure to have on our staff. As our readers know, he is the author of *Gear Cutting Machinery* and is an authority on gear practice, in which line of work his experience will undoubtedly be of great value to our friends, the Fellows Gear Shaper Company, with whom he will be connected.

Our best wishes for his success go with him. L.

* * *

THE BENEFITS OF COOPERATION

The recent meeting of the National Machine Tool Builders' Association exemplifies some of the benefits that come from hearty, whole-souled cooperation. One hundred and sixteen concerns, many of them competitors, came together to promote the common good, which means not only the good of the members, but also of their customers. The association aims to be the means for interchanging ideas by which manufacturing costs shall be reduced, machine design improved, and knowledge of important matters affecting the trade, generally disseminated. But of more importance, it has proved to be a means of inspiration. No one who heard the address on the Cincinnati Continuation School could help being inspired with the feeling that to help others is to help one's self—that altruism has a commercial value. If the employer raises the standard of intelligence and living for his employes, he will surely raise the standard of his product and increase his own prosperity.

The gospel of cooperation is being preached everywhere, but few fully understand and apply it. Cooperation is the keystone of the arch of civilization. A hundred weak threads twisted together make a rope which the strongest man cannot break—many working together accomplish what is impossible for a few. Cooperation in the machine tool business means better shop management, better shops, better men, better product, and better employers. It is as far removed from the popular idea of the trust method of conducting business as one pole is from the other. The initiative of individuals is not stifled, but stimulated. Secret methods have no place in the proceedings, which are characterized by frankness and liberality throughout.

* * *

NEW FIELDS FOR MECHANICAL ENGINEERS

H. L. Gantt's paper, "The Mechanical Engineer and the Textile Industry," read at the Atlantic City convention of the American Society of Mechanical Engineers outlines a new field for the profession. It shows that one important industry in which many opportunities exist for effecting very large economies of operation and improving the grade of product, has been practically neglected by engineers. As an illustration, Mr. Gantt described the common, crude method of bleaching cloth, which requires operatives to work in unhealthful surroundings and results in an irregular product and much confusion in bringing together the cloth of different mills when the bleaching is completed. The improvement as described was effected by designing simple apparatus which enabled the cloth to pass progressively from one bath to another without break and almost without the aid of human labor.

The changes were of so simple a nature that practically any mechanical engineer would have worked out essentially the same means of accomplishing the desired result, had he been required to improve the existing conditions. But strange as it will seem to the readers of this journal, practically every bleachery in this country or Europe is following the old crude method, illogical in plan and unsatisfactory in product. Parallel conditions, not so readily improved perhaps, exist in the textile industry generally, and doubtless in many others which so far have not received the critical attention of trained minds. The technical colleges have largely devoted themselves to the training of power plant engineers, neglecting fields of endeavor where vastly greater economies are possible.

* * *

GRINDING GAS ENGINE CYLINDERS

There is an honest difference of opinion, shared by engineers and manufacturers alike, as to the desirability of internally grinding gas engine cylinders. Those opposed to the practice say it is a useless refinement practiced by certain automobile manufacturers more for the purpose of making a good talking point than for anything else. They say that the bored cylinder has exactly the kind of surface required to quickly wear the piston rings to a smooth bearing, and that after lapping it is more likely to be tight than a ground cylinder. The parallel grooves left by the boring tool catch and hold the lubricating oil and check gas leaks, on the principle of action of the so-called water packing grooves sometimes provided in the valve stems and piston rods of hydraulic mechanisms.

The supporters of piston and cylinder grinding make three principal claims for the practice, *viz.*, interchangeability, improved wearing surfaces and the saving of one set of piston rings. By grinding both cylinders and pistons, perfect interchangeability may be secured at low cost, all scraping, filing and fitting being avoided. Anyone acquainted with the economies of a strictly interchangeable system of manufacture will fully appreciate this feature. Fitting, in the common way, is a time-consuming process, especially when done by the use of abrasives. When finished by grinding, the wearing surface is perfect at the start, and the cylinder begins its work with a standard size bore. This latter condition is impossible with the boring and lapping method. Lapping will wear the bore of the common automobile engine cylinder 0.006 inch larger perhaps, and then it may be neither round nor straight. The process wears out a set of piston rings and a new set must be furnished after the finishing operations are completed, which, of course, means double cost for piston rings.

Judging from the experience of users, it appears to an unprejudiced observer that grinding machines, of both the external and internal types, will be among the machine tools most highly prized by gas engine builders when they fully understand and appreciate their possibilities and economies, and have trained workmen to use them efficiently.

FORCE REQUIRED FOR BENDING

It is a curious fact and one not very creditable to the authors, that practically all the text-books on mechanics treat bending stresses and resistance to bending from the viewpoint that bending is to be resisted. In the design of most machines and structures this view-point is perfectly correct, but if the designer requires to know the force that will actually bend a bar or beam, he will find no direct information on the subject in the great mass of engineering literature. Of course, it does not require profound reasoning to deduce the fact that the ordinary beam formulas apply just the same whether the beam is to bend or resist bending, but doubtless it would comfort the callow engineer to be assured that, for example, $P = \frac{S l t^2}{6}$ can be used to find the force required to bend a plate held at one edge, if he will but insert a value S equal to or slightly greater than the elastic limit of the material.

* * *

WHERE ARE OUR MARKETS?

The total value of metal working machinery manufactured in the United States amounted to $32,408,766 in 1905, the last year for which census figures are available. The value of the same product in 1900 was $24,737,904, and the same proportionate increase during the past five years would bring the total for 1910 to $42,000,000 or more.

Our exports for each of the years from 1905 to 1909 inclusive, were as follows:

Year	Europe	Canada	West Indies, Central and So. America	Asia	All other Countries	Total
1905	$3,718,824	$150,180	$143,148	$245,066	$ 75,447	$4,332,665
1906	5,825,505	169,206	207,060	114,507	129,334	6,445,612
1907	8,423,471	261,272	329,255	255,551	99,507	9,369,056
1908	6,859,319	551,155	544,435	514,430	226,896	8,696,235
1909	2,853,605	223,650	345,447	88,374	128,958	3,640,034

A comparison of these figures shows that the great market for American machinery is at home; and while due attention should be given to foreign outlets, the home market is the one which best repays cultivation, for this belongs to American manufacturers and cannot be taken away from them unless there is a material change in conditions. There is no doubt that our home market can be substantially increased, even though the process may be a slow one, and one requiring attention to problems other than those purely commercial. The manufacture of machine tools is a basic industry, and a larger home market for its product can be created by an increased development of the resources of the country, for which there are vast opportunities. In proportion to its area and natural wealth, the country is as yet sparsely settled; but the opportunities for development are being monopolized, and natural resources that could be used in various industries are held out of use. Under such conditions the country cannot develop as rapidly as if its resources were open to such enterprise as would make the best immediate use of them.

The proper use of our natural resources is not contrary to the idea of conservation. It is true that the consumption of coal and other mineral wealth gradually exhausts the supply, but no other resources of the country diminish or decrease in value through proper use. Among those which, with proper care, should be virtually inexhaustible, are the water power, a valuable natural asset, the forests, which can and should be replanted, and the land itself, which, for agricultural and other purposes is to a very large extent held out of use. If we really want to create larger home markets, monopoly in these natural resources must be opposed by logical and intelligent methods, and the greatest possible freedom given to competitive enterprise wherever it manifests itself. Thus a much greater home market than the present one can be created, and the United States can become more independent of foreign trade, for which the competition is constantly increasing.

GOULD & EBERHARDT'S APPRENTICESHIP SYSTEM*

By FRED L. EBERHARDT†

With the necessary requisites in mind we select applicants for apprenticeship from our public grammar and high schools by applying to the superintendent of public schools and his principals; also to our Newark Technical School, Municipal Labor Bureau, and by advertising in the daily papers, alternating our advertisements by first appealing to the boys themselves and second to the parents, approaching the latter from the standpoint that they should not overlook their responsibility in considering their sons' future welfare and earning power. Too many parents look only at the present and think, because their boys can earn $6, $7, $8, or $9 per week, that it is helping them more than to put the boys out at lower wages, and no doubt there is a good deal of truth to this contention. But, if the boy is made of the proper mettle and has the natural ability, he would be destined for far greater results in a few years than if he had not started on a trade at all. We would lay great stress on the need of educating parents to allow their boys who have a mechanical inclination to serve an apprenticeship of say, four years, in a well-regulated factory. While not making it obligatory, we strongly advocate our apprentices attending the Newark Evening Technical School, from which a number of our apprentices have been graduated.

At present we have about 65 apprentices, all bound and indentured according to the apprenticeship laws of New Jersey, and have none who are not bound in this manner.

We have practically two forms of apprenticeship, one for young men about seventeen years of age, embracing what we term our regular course and covering a period of four years of 10,800 hours, and another for two years, or 5400 hours, called our "one-branch," and intended for young men 21 years and older. Reckoning a year at 2700 hours, in the case of our four-year course, we have a first period of 2000 hours at 8 cents per hour, a second 2000 hours at 9 cents, a third 2000 hours at 10 cents, a fourth 2000 hours at 11 cents and a fifth 2800 hours at 12 cents. This makes a total of 10,800 hours.

The total hours in each period are required to be completed before the next advance in pay is made. We require that the apprentices' parents shall pay us $1 per week during the first four periods, which amount forms the collateral for a bond which the father or guardian is required to execute. This amount is returned at the expiration of the term, if the said term is completed in a satisfactory manner. However, if for any reason the terms of the papers are violated or the young man runs away, the money paid on account is forfeited. Incidentally, I would say that the amount which we pay the young man, as stated above, is larger than what it was formerly. We made it sufficiently more for the purpose of enabling the parent to pay back the $1 per week to make good the bond. In this way, we feel, we make it more feasible for a worthy young man, so to say, to pay his own way so far as securing a bondsman is concerned, a collateral bond always having been one of our requirements.

The regular apprenticeship course includes work at the vise, lathe and planer. In addition, milling machine and gear cutting machine experience, and also other work, is afforded to those boys who show ability to absorb.

Our experience has taught us that there is so great a variation in capacity that wherever we see a boy who shows ability we do not hesitate to advance him, and when we find a boy who does not possess ability we strongly advise him and his parents to have him take up some other line of work. This we do within the first 4000 hours of service. It does not always take 4000 hours to determine this, but there are times when, before taking summary dismissal measures, we try out a boy at more than one branch, or place him with different foremen, so that, in the final disposition of the case, neither the parent nor the boy can say that he was not given a fair trial. For all these efforts expended on the boy up to this time, should he prove deficient and be dismissed, we require that whatever money has been paid on account of the bond be

* Abstract of paper read before the Convention of the National Machine Tool Builders' Association, in Rochester, N. Y., May 25, 1910.
† President of Gould & Eberhardt, Newark, N. J.

forfeited. This is, in a measure, partly to compensate us for the time spent, work spoiled, etc., in giving the boy a chance to demonstrate, in our opinion or judgment, whether or not he is suited for the trade. The necessity for this measure does not occur often, but we feel that it is absolutely necessary to have some such method of procedure.

Our second form of apprenticeship, called our one-branch, is for young men who, having attained their majority, realize the necessity for learning some trade and regret not having been given the opportunity in earlier years. This apprenticeship, as stated, is for two years, or 5400 hours, divided into periods of 2700 hours each, the first at 12 cents per hour and the second at 14 cents per hour. We require the young men themselves to pay us $1 per week, the same as before explained. This amounts to about $165 in the four-year course and $130 in the two-year course, and in each case is paid back at the expiration of the term when completed in a satisfactory manner. This latter amount is also subject to the same penalties as previously mentioned.

At the present time we have seven in our drafting-room. Our chief draftsman and three journeymen draftsmen were our own apprentices at the machinist's trade. Another is an apprentice at the machinist's trade, and has been given drawing-room privileges and practice. One of the journeymen draftsmen is foreign born and a trained technical graduate. We do not include instruction in the foundry or pattern-shop generally, although all of the apprentices who gain drawing-room experience have access to and come in contact with the work in the pattern-shop and foundry. For the foundry and pattern-shop we have similar but special and separate courses.

All of our apprentices during their apprenticeship are furnished with the necessary tools required in the several branches, and we pass free title to them upon the apprentice completing his term.

* * *

CASEHARDENING PRACTICE AT THE JUNIATA SHOPS OF THE PENNSYLVANIA R. R.

We are now able to give more detailed information on casehardening practice at the Juniata Shops of the Pennsylvania Railroad, as described in the June, 1910, number of MACHINERY, on page 824 of the engineering and railway editions. This information relates particularly to the method of packing the work, and to the use of test pieces to determine the quality and depth of the hardening. The following formula is used as a packing mixture:

11 pounds prussiate of potash.
30 pounds sal soda.
20 pounds coarse salt.
6 bushels powdered charcoal (hickory preferred).

The whole is mixed thoroughly, using about 30 quarts of water in the mixing; the above quantity is sufficient to harden three boxes of material containing the following parts:

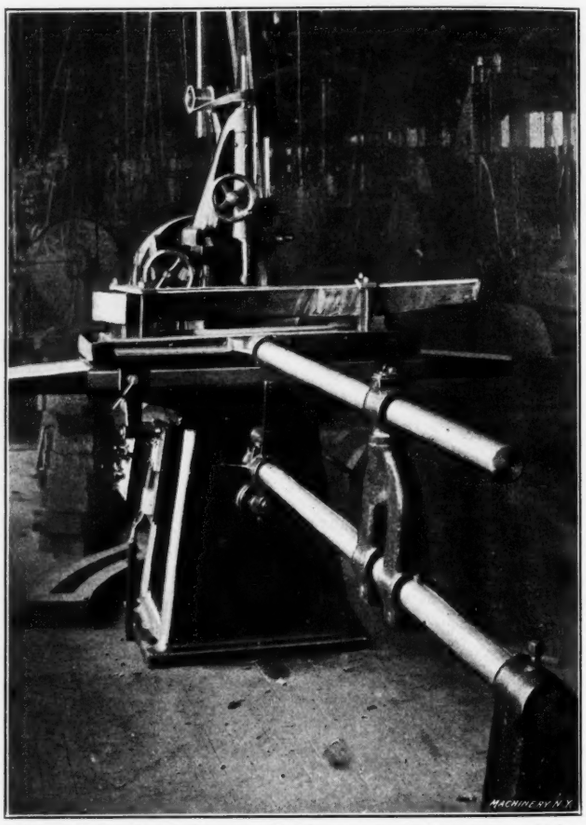
2 links, 2 link blocks, 2 link-block pins, 2 valve-rod pins, 4 knuckle-joint pins, and 24 gibs for spring rigging.

The box required to hold these parts measures 40 inches long, 16 inches wide, and 12 inches deep; the time required to harden them properly is fourteen hours. Smaller parts, like link die plates, eccentric-rod jaw pins, and nuts below 1 inch, are usually packed in smaller boxes, or pipe 8 inches in diameter, which require between four and five hours heating. Link motion bushings and similar light parts are also packed in small boxes or pipe and require from two and a half to three hours.

The following method is pursued in packing the material: The bottom of the box is covered to a depth of 2 inches with the compound; the parts to be hardened are placed solidly, so that the compound is in contact with the bottom surface of the work; care is taken, however, that the work does not touch the sides of the box or other pieces in the box. After the first layer of the material is placed, it is covered on all sides and on the top with the compound, and is solidly packed with a suitable implement—a bolt with a large head will do. After the first layer is packed the same process is repeated, being sure to have sufficient compound between the two layers to prevent contact. There should not be less than 2 inches of compound on top of the last layer. The lid which fits inside the box is then thoroughly sealed with a luting of fire clay.

When in the furnace, the box rests on rollers to allow the flames to pass under it. The furnace is kept at a bright red heat, but not hot enough to scale or blister the work; when the material has soaked in the fire a sufficient length of time, the box is withdrawn to a trestle which is flush with the floor of the furnace, and stands parallel with and close to the water tank. The lid is then removed from the box and, if links are being hardened the link is turned on edge and a bar passed through the slot in the link and lifted by two men, being plunged into the water endwise; the bar is then withdrawn and the link is allowed to remain in the tank until cold.

The best results are obtained when the contents of the box can be emptied into the water at once. The tank used has a line of 1½-inch iron pipe connected with the service pipe, running around the four sides and close to the bottom, with ¼-inch holes drilled about 1½ inch apart. This supplies cold



Hammett Grinding Machine for Finishing the Slots of Locomotive Links

water to the work and drives the hot water to the top, where it is carried to the sewer by means of an overflow pipe.

With each box of material to be hardened a test piece is used, the same as described in the article last month. In the case of links, the test piece is 1¼ inch thick by 3 inches wide, and 12 inches long; this test piece is stenciled with figures giving the class of engine, the construction number and the date of hardening. After the links are taken out, the test piece is broken under hydraulic pressure and examined for depth of hardening, after which it is also subjected to a file test. Smaller parts are similarly tested. These test pieces are kept for two years or more for reference. It is possible to put from 1/16 inch to 5/32 inch depth of case on the link work in fourteen hours' time, and 1/16 inch on bushings and other small parts in from two and a half to three hours' time. All parts to be casehardened must be thoroughly cleaned.

It was stated that the slots of the valve gear links are ground accurately to fit the radius templet shown in Fig. 24 of the article in the June number. The accompanying illustration shows the machine on which this grinding is done. It is a vertical spindle machine, as may be seen, the work being clamped to the top of a flat table. This work table is free to swivel, and to move in and out on top of the longitudinal slide which carries it. It is guided by a long radius rod, as shown, which is attached to a pivot adjustable to any required radius.

AUTOMOBILE FACTORY PRACTICE

THE OLDS MOTOR WORKS, LANSING, MICH.

By ETHAN VIALL*

To the man traveling through Michigan for the first time, it almost seems as if the sole product of the state were automobiles, furniture and breakfast foods, and a fair-sized town that doesn't boast of a factory for the production of at least one of these, is apparently out of the running and should at once shake up its chamber of commerce or its commercial club or whatever it happens to possess for the stimulation of its growth. The production of furniture or breakfast foods does not concern us, mechanically speaking, to the same extent as do automobiles, though if we sit in a good comfortable chair while eating our breakfast we are in better condition to enjoy our automobile ride later.

The first automobiles the writer ever saw of any one make, in respectable numbers, were those little curved-dash Oldsmobile runabouts, so familiar a few years ago, which were made at Detroit. To-day the Olds Motor Works has large factories at Lansing, Mich., where they are producing thousands of Oldsmobiles, some of them sixty horsepower six-cylinder cars. The shop practice, while not radically different from that of other similar factories, is nevertheless interesting and well repays the student of practical mechanics who is fortunate enough to have an opportunity to inspect the factory and its methods. Mr. Robert Pierpont is the factory manager.

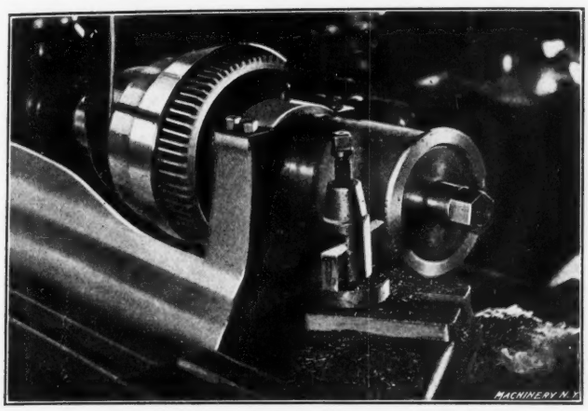


Fig. 1. Turning the Chucking Flange on Piston Ring Casting

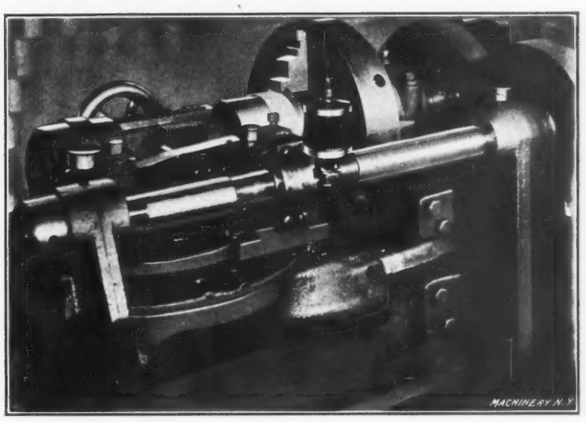


Fig. 2. Turning the Outside and Cutting off Piston Rings

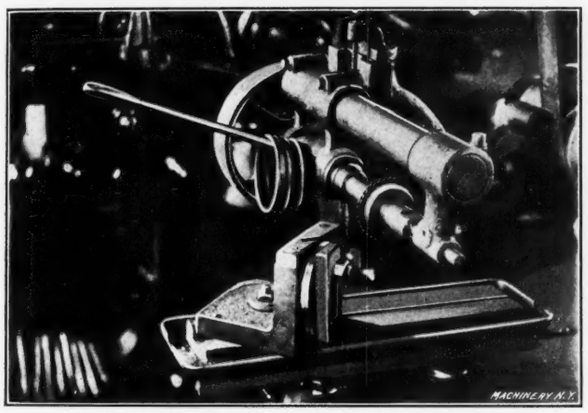


Fig. 3. Machine in which Piston Rings are split

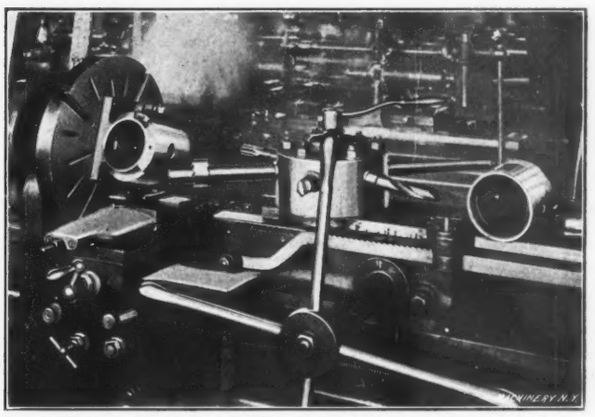


Fig. 4. Turret Lathe set up for Drilling, Boring and Reaming Wrist-pin Bosses

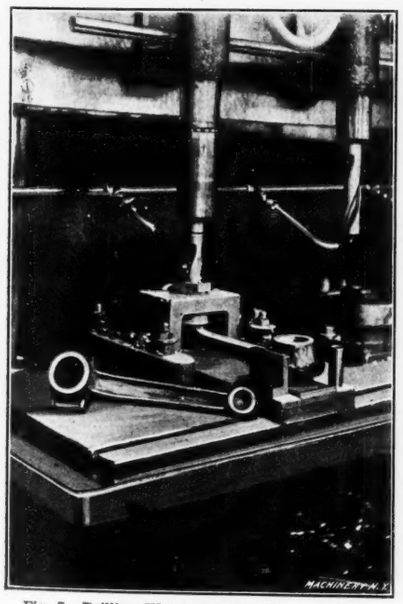


Fig. 5. Drilling Wrist-pin End of Connecting-rod Forging

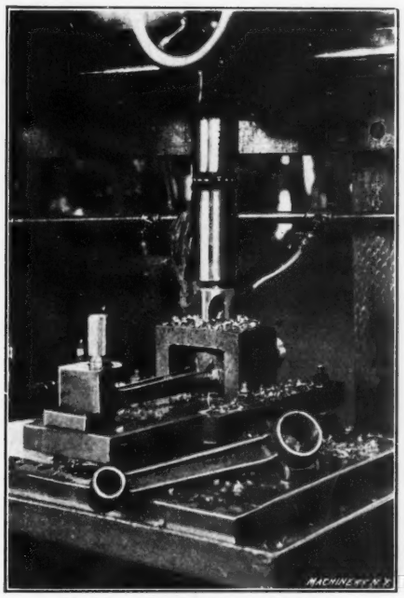


Fig. 6. Drilling Crank-end of Connecting-rod

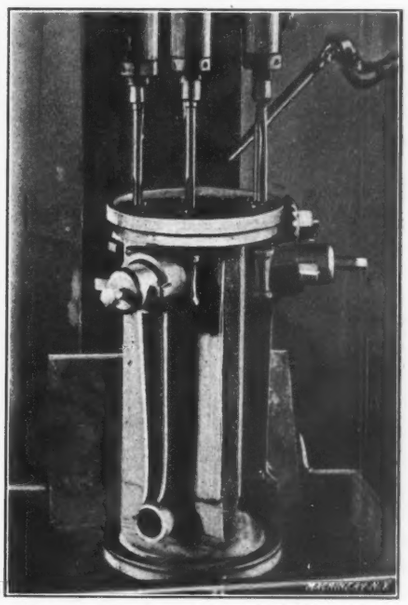


Fig. 7. Drilling, Reaming and Finish Reaming Cap-screw Holes

*Associate Editor of MACHINERY.

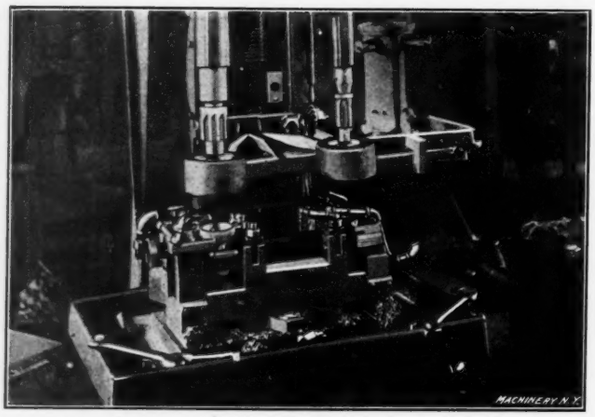


Fig. 8. Fixture in which Connecting-rod Ends are reamed

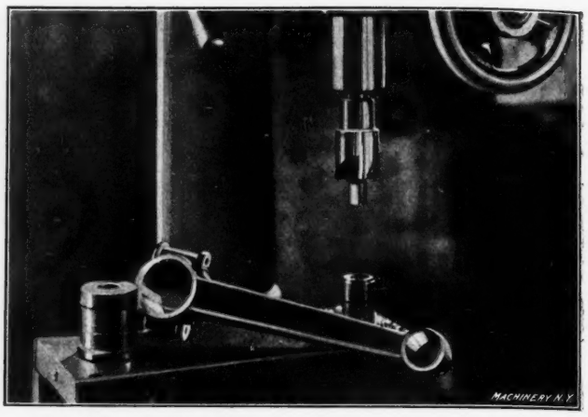


Fig. 9. Tool and Fixture for Facing Bearings to Width

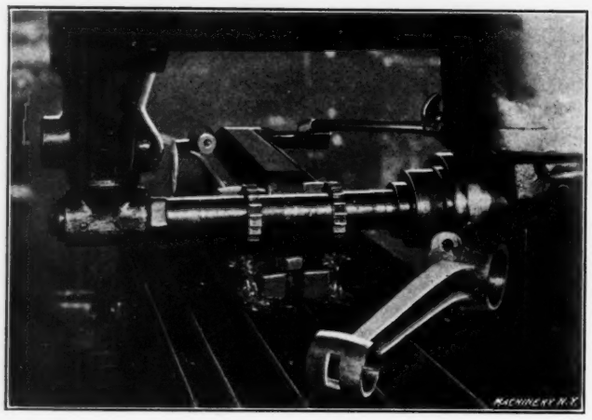


Fig. 10. Milling Oil-slots in the Connecting-rods

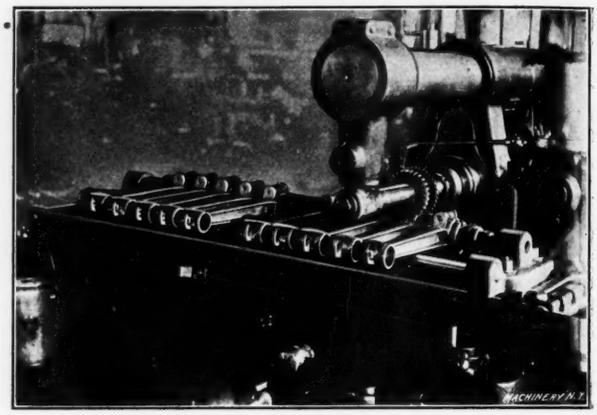


Fig. 11. Sawing off the Caps and facing Seats for Bolt Heads

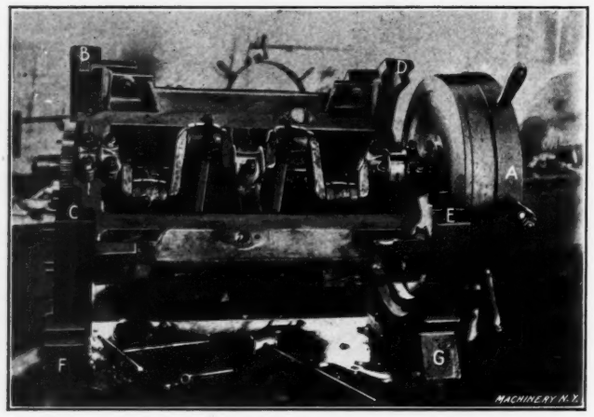


Fig. 12. Revolving Fixture in which Rods are assembled on the Cranks

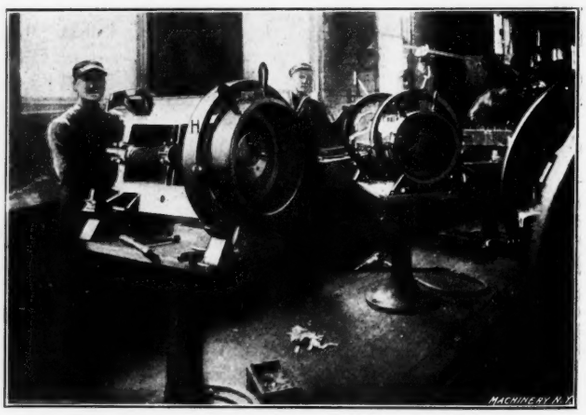


Fig. 13. Another View of the Revolving Assembling Stands

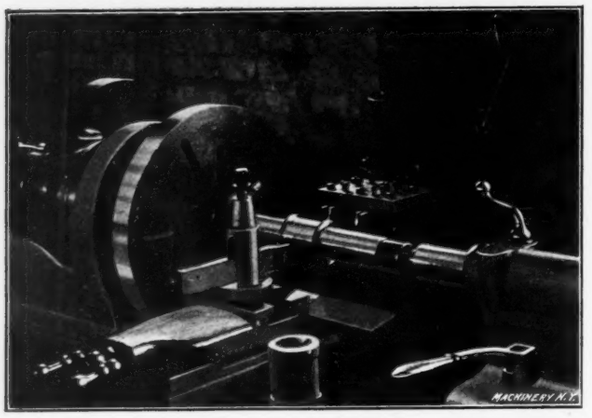


Fig. 14. Turning the Outside of Connecting-rod Bushings

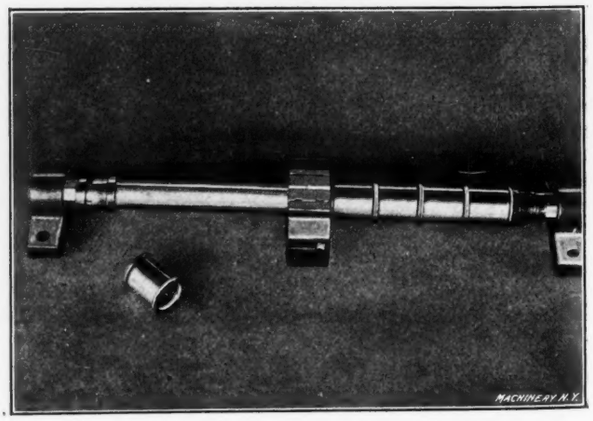


Fig. 15. Mandrel used when splitting Connecting-rod Bushings

Packing Rings and Pistons

The cast-iron sleeve from which the piston rings are made is first placed on an expanding mandrel and the flanged end turned, as shown in Fig. 1; it is then caught in the grooved jaws of a universal chuck, Fig. 2. The machine shown in

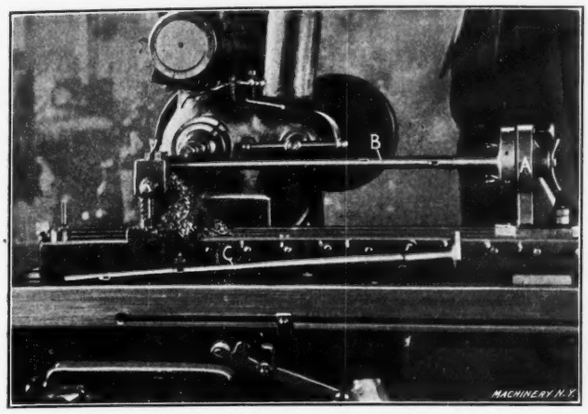


Fig. 16. Fixture for Holding Cam-shafts while Milling for Woodruff Keys

this engraving is a lathe to which has been added the turning attachment shown, which turns the outside of the rings eccentric and cuts them off; the inside of the ring not being bored out as is the practice in many shops. Just why so many shops spend time and trouble boring out the inside of the

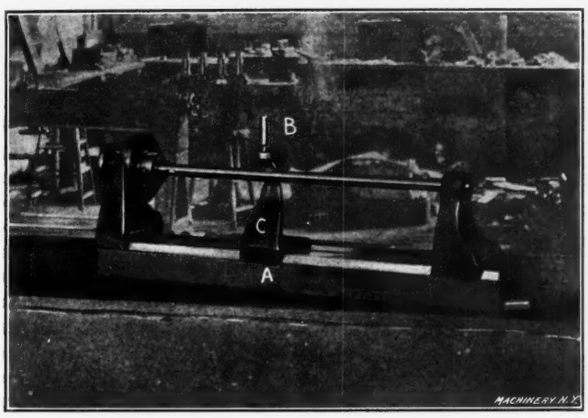


Fig. 17. Inspector's Fixture for Testing Cam-shaft Keyways

ring is not clear, as it not only takes so much more time, which, of course, increases the cost, but also decreases the value and life of the ring by the removal of the hard surface. After being turned and cut off, the rings are placed in a jig and split by using two milling saws properly spaced,

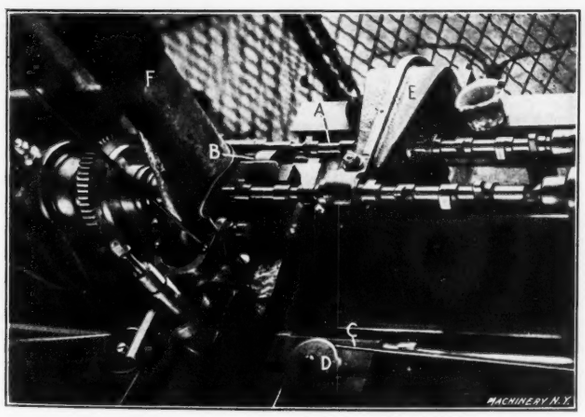


Fig. 18. Top View of Lathe equipped with Cam-grinding Attachment

as shown in Fig. 3; they are then compressed in sleeves, clamped on a flanged mandrel and ground as usual.

Wrist-pin holes in the pistons are drilled and reamed, after which the inside ends of the bosses are faced with a double-end mill in a turret lathe fitted as shown in Fig. 4.

Steps in Connecting-rod Production

The first machine shop operation on a connecting-rod consists in surfacing the ends of the bearings on a milling machine, there being 3/32 of an inch difference in the width of the bearings; the rod is then placed in the jig shown in Fig. 5 and the small bearing drilled out, after which it is placed in another jig and the large end drilled, the proper spacing being obtained by using a plug in the small end as shown in Fig. 6. Next both ends of the connecting-rod are finish-reamed in the jig, Fig. 8. The ends are then faced to the exact thickness, by using a butt-mill with a pilot which fits the holes in the bearing posts of the jig, Fig. 9. From here the connecting-rod goes to the triple drilling jig, Fig. 7, where the clearance holes for the cap-screws are rough drilled and finish reamed; all three operations are performed simultaneously, so that a finished rod is taken out and a new one put in every time the jig is indexed. The next operation consists of milling a slot

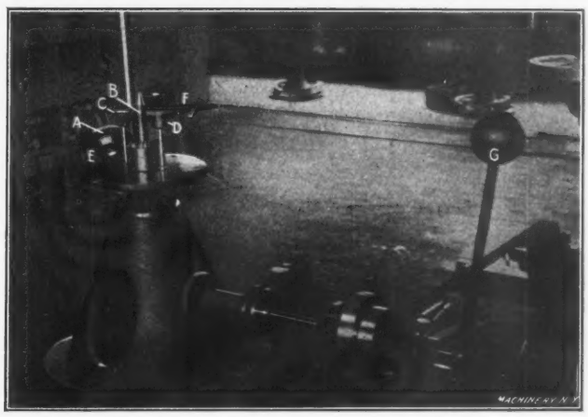


Fig. 19. Machine used for Balancing Flywheels

in the small end for the oil hole, as shown in Fig. 10. The rods are then placed, ten at a time, in the milling jig, Fig. 11, where the caps are cut off and the inner ends, or bosses of the cap bolt-holes, faced in two operations; one cut is taken, the connecting-rods are turned over on the clamping mandrel and the final cut made. After the Parsons' white bronze bushings

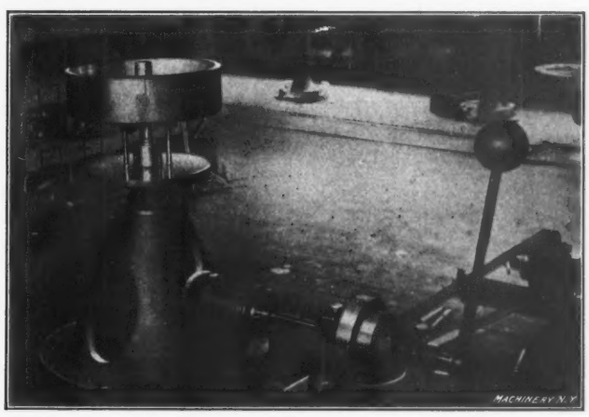


Fig. 20. Balancing Machine with Flywheel in Place

have been pinned into the large end, the rods are placed in the pistons, but they are not put onto the crankshaft until ready for assembling as shown in Fig. 12. In connection with this last engraving and Fig. 13, the scheme used to revolve the flywheel and crankshaft, while assembling and adjusting, by means of a handled band strapped to the rim of the flywheel, is made plain. The revolving assembling stands shown are also very unique as well as efficient, the motor case being bolted to the inside of a pair of cast-iron rings resting on guides bolted to a base, which is swiveled to the top of a cast-iron stand; this arrangement always keeps the center line of the crankshaft parallel with the floor, still allowing universal movement in any other direction. Referring to Fig. 12, the flywheel band is shown at *A*, while *B*, *C*, *D*, and *E* are the ends of the wheel segments which are removed to put in or take out the motor; *F* and *G* are guides or pillows

for the wheels. In Fig. 13, *H*, *I*, and *J* show the wheels complete, with segments in place.

The white bronze split bushings, used on the crank ends of connecting-rods, are first chucked, bored out and reamed, and then placed on a mandrel, as in Fig. 14. The hub is turned with the tool in the regular toolpost and the flanges finished with the gang tool in the holder placed on the back of the cross-slide. After being turned, the bushings are split by being placed eight at a time on the mandrel, Fig. 15; they are clamped tight by screwing up the nuts on each end of the mandrel, and then split with a thin milling saw, the mandrel being turned half way around for the last cut.

Milling and Grinding Cam-shafts

There is a very neat fixture used in the milling machine department for milling Woodruff keyways in the cam-shafts.

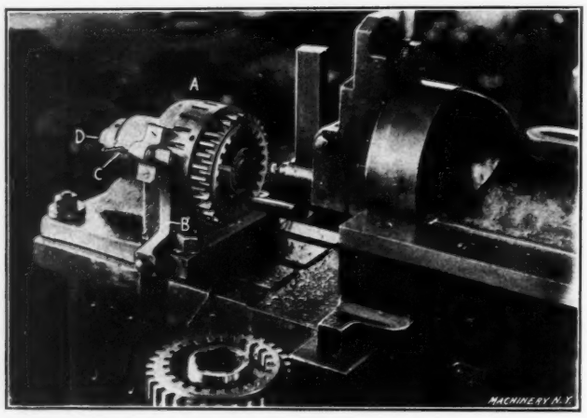


Fig. 21. Cutting Inside Clutch Teeth on a Shaper

This fixture, Fig. 16, is made with an index head *A*, used to give the proper position of the keyways on the shaft *B*, the spacing lengthwise of the shaft being obtained by carriage stops. A finished cam-shaft is shown at *C*. After being milled, the positions and sizes of the keyways are tested by an inspector, using the fixture shown at *A*, Fig. 17, which also has an accurate indexing head. The size and central position of the keyways are tested by a plug *B*, in the sliding part *C*.

The cams are ground, after being keyed and pinned to the shaft, by using a special grinding attachment fitted to a lathe,

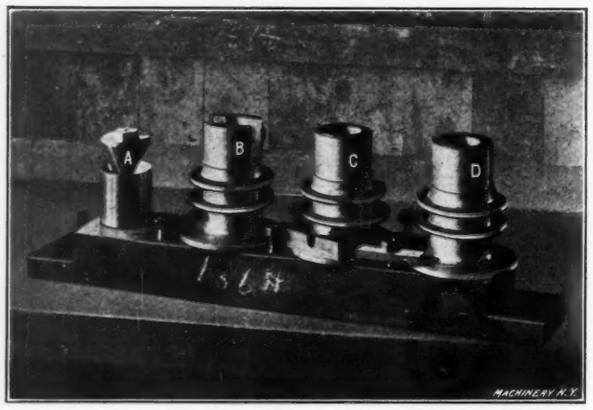


Fig. 22. Milling Fixture in which Work is held on Expanding Plugs

Fig. 18. The master cam-shaft *A*, is geared to the lathe head so as to revolve at the same rate as the shaft to be ground. The cams on the master shaft impart motion to the carriage and grinding wheel through the roller *B*, the carriage being held to the work and to the master cam by the weighted cord *C*, which passes around pulley *D* and another pulley not shown. The master shaft and the shaft to be ground are both supported in the middle by the steady-rest *E*. The emery wheel held by the fork in the toolpost, is run by a round belt passing over a long overhead drum, and the dust is carried off through the pipe *F*. Very rapid and satisfactory work is done with this attachment.

Balancing Flywheels

All flywheels are balanced on a Defiance balancing machine shown in Figs. 19 and 20. Fig. 19 shows the machine with the balancing or floating head *A*, to which the flywheel is fastened, lying on the revolving table; this floating head fits over the pin *B* and is driven by the rubber-headed pins *C* and *D*, which come in contact with the part *E*; *F* is an arm used to steady the operator's hand while holding a piece of chalk to the revolving rim of the flywheel. Putty is stuck onto the inside of the flywheel rim to bring it to a running balance, and the amount of putty used forms a basis for judging the amount of metal to be drilled out. The machine is set in motion by throwing over the ball-lever *G*, which engages the frictions.

A Novel Shaper Device

Inside teeth on a special clutch gear, are first drilled and then shaped out, using the indexing fixture *A*, Fig. 21. The inside blank is, of course, counterbored to allow clearance for the cutting tool. The spacing spring *B* is lifted from the notch, when indexing, by means of the eccentric lever *C*. The gear itself is held by an expanding chuck, the taper plug of which is operated by the nut *D*.

An application of the expanding chuck or plug in a milling fixture is shown in Fig. 22. This fixture is made to hold four pieces: *A* shows the expanding plug; *B*, a slotted piece, and *C* and *D*, blanks ready to be milled. In addition to using the expanding plugs, the pieces are also clamped on the flanges by straps, as shown, the bolt holes of which are open on one side to facilitate removal.

* * *

PENSION SYSTEM OF THE WESTERN ELECTRIC COMPANY

In March, 1906, The Western Electric Co. set aside $400,000 out of its profits as a permanent fund for pensions for aged and disabled employes. Since that time another appropriation and interest has been added so that the fund now totals nearly $600,000. All employes who have reached the age of sixty and have been in the company's service for twenty consecutive years are entitled to pensions, whether able to work or not, and are not debarred from going into other business if they accept the pension privileges. Employes who have been twenty-five years in the company's service and reached the age of fifty-five, and those who have been thirty years in the service, irrespective of age reached, may be granted a pension on the recommendation of the president. The annual allowance for employes retired on account of age is one per cent of the average annual pay during the ten years preceding retirement for each year of active service. The pension board may, however, base the pension upon the average annual pay of the ten consecutive years of service during which the retired employe was paid the highest rate of wages. The pension is paid monthly until death, and at the discretion of the board may be continued to the widow or orphans for a period not exceeding one year. The Western Electric Company employs about 20,000 men.

* * *

Halley's comet, which was a disappointing spectacle to the comparatively few who saw it in April and May, is said to have been traveling at the rate of 1000 miles a minute when nearest the sun. This enormous speed, fifty times that of a cannon ball, is practically the same as that of the earth in its orbit about the sun. A 0.22 caliber (short) rifle bullet weighing 30 grains moving with the same velocity would have enormous energy and penetration. Substituting the values in the kinetic energy formula, $E = \frac{Wv^2}{2g}$ in which $E =$ energy, in foot-pounds; $W =$ weight, in pounds; $v =$ velocity, in feet per second; $g =$ acceleration of gravity in one second or 32.2 feet, we have $E = \frac{30 \times 88{,}000^2}{2 \times 32.2 \times 7000} = 515{,}000$ foot-pounds. The penetration would be about 28,000 pine boards ⅞ inch thick if at this high velocity it were proportional to that of rifle bullets at common velocities!

WEIGHTS OF CYLINDRICAL PRESSURE TANKS*

By C. R. WHITTIER†

As the gallon is the common unit of capacity for liquids, it is a great convenience and saving in time to be able to state the weight of a tank in terms of gallons without first converting this into the usual linear dimensions. In general, the weight of such tanks will vary anywhere from two to eight pounds per gallon capacity. It is possible, however, to obtain closer estimates than this when the diameter is known, and a method of stating weight in terms of gallons, pressure and diameter is of great assistance in shortening calculations. This method is worked out below.

First, let us consider the weight of a seamless tank with flat heads. Let

G = capacity in gallons,
T = thickness of shell in sixteenths of an inch,
D = diameter in feet,
L = length in feet,
P = pressure in pounds by gage,
W = weight in pounds.

The steel used in pressure tanks weighs about 490 pounds per cubic foot, and the plates vary in ordinary practice by steps of one-sixteenth of an inch. This is, therefore, the most convenient unit for thickness. A plate of steel, one foot square and 1/16 inch thick, weighs about 2.55 pounds. The ordinary method of estimating the weight of this tank would be to estimate the weight of the shell and heads independently. It will, however, be more convenient for our calculations to estimate the heads in terms of length of shell, just as the length of rivet necessary to form the rivet head is commonly taken as one and one-half diameter.

The area of one head is $\frac{\pi D^2}{4}$. The circumference of the tank is πD. Let x equal the length of shell, the area of which is equal to the area of the head. Then,

$$\pi D x = \frac{\pi D^2}{4}, \text{ and } x = \frac{D}{4}.$$

Hence, the length equivalent to both heads equals $\frac{D}{2}$. The weight of the tank may then be expressed as follows:

Weight = 2.55 × thickness in 16ths × circumference × (length + one-half diameter),

or,

$$W = 2.55\ T \times \pi D \times (L + 0.5\ D) = 8\ DT\ (L + 0.5\ D).$$

To save bracing, the heads of pressure tanks are commonly dished to a radius equal to the diameter of the shell. To find the area of the spherical segment, assume for simplicity that the diameter of the tank equals 2. The distance from the center of the sphere to the original flat head is given by solving the right-angled triangle whose hypotenuse equals 2 and one side equals 1. This distance, therefore, equals $\sqrt{4 - 1} = 1.732$, and the height of the segment = 2 — 1.732 = 0.268. The area of this spherical segment = height × circumference of a great circle = 0.268 × 2 πD, and, as $D = 2$, the area = 1.072 π. The area of the flat head was $\frac{\pi D^2}{4}$, and as $D = 2$, the area = π.

We thus see that the area and weight of the spherical head is about 7 per cent more than the flat head. This holds true for all dimensions. In riveted pressure tanks varying from 4 to 8 feet in diameter, however, the dished heads are commonly made 1/16 inch thicker than the shell. As the shell thickness averages 5/8 inch and the head thickness 11/16 inch, the heads are, on an average, 10 per cent per square foot heavier than the shell. This is sufficiently close for our present purpose. Multiplying the two percentages: 1.07 × 1.10 = 1.18; that is, for ordinary dished heads, to obtain the equivalent length of shell, the increase over the equivalent length for the flat heads first mentioned is 18 per cent.

In the same manner, the manhole, nozzles, reinforcing plates, inside pipes, supports, etc., which are commonly used in such tanks, can be estimated in percentages, and transformed to an equivalent length of shell. Without going into these numerous details, it will be sufficient to state that it is found that these factors increase the equivalent length of shell from $L + 0.5\ D$ to $L + D$, very closely. The formula therefore now stands:

$$W = 8\ DT\ (L + D)$$

Having thus determined the general form of our equation and its main factors, it now becomes necessary to make an allowance for the increase in weight due to joints, rivet heads, variable thickness of metal, etc. Of course, this could also be reduced to equivalent length of shell, but this allowance can also be made by increasing the numerical coefficient by a certain percentage, and this method gives the most convenient formula. It is best done by comparison with the actual finished weights of tanks which have been constructed. Ordinarily, in place of 8, it will be found necessary to make this coefficient between 9 and 10. It can be easily determined for any tank by dividing its actual weight by $DT\ (L + D)$. For instance, in a line of tanks, nearly one hundred in number, varying from 5/16 inch to 7/8 inch in thickness, from 4 to 8½ feet in diameter, and from 5 to 50 feet in length, with pressures varying from 50 to 200 pounds per square inch, it was found as the result of the above determinations that the coefficient 10 gave the closest average for all the tanks, the maximum variation being very slight each way. We, therefore, have for this line of tanks:

$$W = 10\ DT\ (L + D).$$

This is an exceedingly simple formula for determining the weight of similar tanks when the diameter, thickness of shell and length are known. It now remains to substitute gallons and pressure for length and thickness.

Ignoring, for the present, the additional capacity given by dishing the heads, the capacity in cubic feet of our cylinder = area × length = $\frac{\pi D^2}{4} \times L$. As 7.481 gallons equals one cubic foot, the capacity in gallons is:

$$G = 7.481 \times \frac{\pi D^2}{4} \times L = 5.876\ D^2 L.$$

Adding about 2 per cent as a fair average for the additional capacity obtained by dishing the heads, we have:

$$G = 6\ D^2 L.$$

These tanks are usually designed with a factor of safety of 5, using steel of 55,000 to 60,000 pounds ultimate tensile strength.

The standard longitudinal seams are as follows:

A. A double strap, triple riveted butt joint, of an efficiency at the common thicknesses varying from 83 to 88 per cent.

B. A double riveted lap joint, with an efficiency ranging from 60 to 74 per cent.

C. A single riveted lap joint, with an efficiency from 51 to 59 per cent.

The process of reduction is too long to be given here, but by plotting and deducing the equation for the ordinary diameters, thickness and pressures, the following formulas can be deduced:

For *A*, $T = 0.01\ PD$
For *B*, $T = 0.013\ PD$
For *C*, $T = 0.016\ PD$

For the double strap, triple riveted joint, we therefore have:

$$W = 10\ DT\ (L + D) \quad (1)$$
$$T = 0.01\ PD$$
$$G = 6\ D^2 L$$

By substituting the value of T in (1) we have:

$$W = 10\ D\ (0.01\ PD)\ (L + D) = 0.1\ PD^2\ (L + D) = 0.1\ PLD^2 + 0.1\ PD^3.$$

As $\frac{G}{60} = 0.1\ D^2 L$, we have by substitution:

$$W = P\frac{G}{60} + 0.1\ PD^3, \text{ or } W = P\left(\frac{G}{60} + 0.1\ D^3\right)$$

* With Data Sheet Supplement.
† Address: 204 W. 111th St., New York City.

In a similar manner; for the double rivet lap joint:

$$W = P\left(\frac{G}{46} + 0.1\ D^3\right)$$

For the single riveted lap joint:

$$W = P\left(\frac{G}{37} + 0.1\ D^3\right)$$

Summary of Formulas

We have, then, the following simple formulas for determining the capacity, thickness and weight of tanks of the class referred to:

For capacity $G = 6\ D^2\ L$.

For double strap, triple riveted butt joints, $T = 0.01\ PD$

For double riveted lap joints, $T = 0.013\ PD$

For single riveted lap joints, $T = 0.016\ PD$

Then by dimensions:

$$W = 10\ DT\ (L + D)$$

By capacity:

For double strap, triple riveted butt joints, $W = P\ (G/60 + 0.1D^3)$

For double riveted lap joints, $W = P\ (G/46 + 0.1D^3)$

For single riveted lap joints, $W = P\ (G/37 + 0.1D^3)$

Example

For example, assume a tank 5 feet diameter by 20 feet long, for 200 pounds pressure, with double strap, triple riveted longitudinal seams:

By linear dimensions:

$T = 0.01 \times 200 \times 5 = 10$ sixteenths, or $\frac{5}{8}$ inch.

$W = 10 \times 5 \times 10 \times 25 = 12{,}500$ pounds.

$G = 6 \times 25 \times 20 = 3000$ gallons.

If capacity, diameter and pressure are given, we have by the capacity formula:

$W = 200\ (50 + 12.5) = 200 \times 62.5 = 12{,}500$ pounds, which is the same result as before.

For all preliminary work, this short-cut method will be found sufficiently accurate. It can be readily supplemented by the ordinary summation method when desirable. Three of the Data Sheets accompanying this number contain tables and diagrams of the data here deduced.

* * *

CONE VS. GEARED DRIVE*

By R. K. LeBLOND†

Some years ago, I wrote an advertisement which appeared in trade papers, in which I stated that a double friction back gear was the best drive that had ever been applied to a machine tool. I suppose when the committee was looking around for different modes of entertainment and instruction, some member suggested that we could have a debate on the relative merits of the cone and geared drive, and as I had so fearlessly expressed my opinion, some one suggested my name. I did not like to show the "white feather," so I am here to-day to defend my stand as originally taken on cone drives, although we manufacture both styles of machines.

The question of cone- and gear-driven machines is very similar to the tariff—each side has a great many good points on which to base an argument. Free trade, for instance, is practically advocated by all college professors, and as a well-known writer remarked, all graduates ,as they emerge from college, are ardent free-traders, but as they get into the practical workings of life, most of them are soon converted to the tariff policy.

This condition exists in the cone and geared head proposition. Theoretically, the geared head drive has the most advantages, and the present development is along the geared head lines, but practically and commercially, the cone drive is more than holding its own, and as we gather our costly experience from miscellaneous experiments on gear-driven machines, we discover that the old reliable cone drive is still an important factor in machine tool design.

We all realize that the demand for the gear drive originated with the advent of high-speed steel; in other words, when the cutting tools were perfected to such an extent that they could stand the speeds and the heat generated by these speeds, the old-style cone drives were found lacking in power, and some of the manufacturers immediately decided upon a method of gearing to increase the power. This, in my judgment, was a temporary and poor remedy, and very costly to the manufacturer. While I am loth to say it, very few of the lighter classes of machine tools were scientifically designed, and gear drive design was begun more or less on a hit-and-miss plan.

In looking over the various gear drives that have been produced in the last few years, we are naturally surprised at the varied mechanisms employed, at the ignorance displayed in the selection of metals, the pitches of gears, the size and material of shafts, oiling facilities, etc. While this is a defect in individual construction, and not a fundamental defect of the geared head, it all goes to show that the development has been more or less experimental, and extends through the complete range of frictions, tumbling gears, sliding gears *a la* automobile, etc.

As a matter of fact, all the advantages claimed for the geared head machine, can be obtained better with a variable speed motor and comparatively few mechanical changes. The electrical changes can be obtained with a much smaller friction loss—that is, more efficiently; the change increments are much smaller and the speeds can always be obtained while the machine is in motion without stopping for changes and without a countershaft, etc. In other words, the variable speed motor drive is the ideal geared head.

The common defects in all gear-driven machines are: lack of efficiency, expense of maintenance, and the increased first cost. This holds true regardless of the changes being made in one unit or distributed in two, one being placed on the ceiling. We will take these comparisons up separately:

Efficiency of the Geared Machine

In extreme cases but 40 per cent of the power applied to the machine is delivered to the cutting tool or spindle. In the case of feeds, as shown by Mr. DeLeeuw's experiments [See "Efficiency Tests of Milling Machines and Milling Cutters," MACHINERY, December, 1908.] the friction on the shafts and gears has reduced this as low as 2 per cent and under the very best conditions, 20 per cent of the power applied. Of course, this is an extreme case and is due primarily to the fact that the reduction is so great and that the power has to pass through a screw, which as we all know, is a very inefficient method of power transmission. But in the construction of various designs of geared head machines, we see the worm and worm-wheel, and bevel gear, as well as spur gear.

I recently visited a large machine tool plant. In going through the shop with the superintendent, we stopped at their single pulley driven 16-inch lathe. As we were standing there, an office boy brought a copy of an order for one of these machines to which the purchaser wished to apply a one-horsepower motor. The superintendent immediately said this was impossible, because it takes more than one horsepower to turn the machine over. This was a friction head construction. At the same time, tests made on these lathes by different authorities, under the old belting conditions, resulted in establishing the power consumption of one half horsepower under actual working conditions.

Efficiency of Cone Drive

Now in comparison with this, take the old-fashioned cone. On the direct speeds, or open belt speeds, we can obtain an efficiency as high as 95 per cent, and in the extreme cases of transmitting power through the back-gear it is very seldom lower than 75 per cent. This difference in efficiency has to be taken up by the machine itself. In other words, it is a destructive element. It means friction on the journals, friction on the gears, heat generated which has to be taken up by the body of the machine, and wear in general, from all of which the user obtains no benefit and which goes into the maintenance charge.

Of course, it is an easy matter for the exponents of the geared drive to say that the power factor in machining costs is so slight that it is not to be considered. That is true, to a great extent, but when analyzed it will be found not to be simply the difference in the coal bill.

As an instance, a production man in one of the largest plants in the East, had formerly purchased all all-geared ma-

*Paper read before the National Machine Tool Builders' Convention, Rochester, N. Y., May 24-25, 1910.

†Address: R. K. LeBlond Machine Tool Co., Cincinnati, Ohio.

chines. At that time he was simply serving the concern in the capacity of equipment purchasing agent. His position later was changed, and he was given charge of not only the purchasing of tools, but the maintenance as well, whereupon, after thorough investigation, he quit purchasing geared head machines entirely, and purchased nothing but cone-driven machines. The reason given was that he found that the maintenance of the geared head machines outweighed and outclassed the advantages of quick-speed changes, the increased driving power, and all other claims made for the tools.

I think you will find, if you will carefully investigate your overhead charges, that the increased cost of the geared head machine added to the increased maintenance cost added to the increased power cost, will more than outweigh all the advantages claimed by exponents of the all-geared machines.

Fallacy of Instantaneous Speed Changes

I would like to say a word about speed changes. The advocates of the geared machines always harp upon the advantages of instantaneous speed changes. As a matter of fact, one of the best known makers in this country places a plate on his machine, on which he states positively that the machine must be stopped when changing speeds. Another builder has to throw in and out back gears when making the change of speeds which necessitates the stopping of the machine. The only instantaneous change machines are the friction clutch machines, which are always more or less a cause of annoyance and trouble.

Another claim made for this type of machine, which is not lived up to except in a very few cases, is that the machines can be driven direct from the lineshaft and require no countershaft or overhead works. This is more of a theoretical than a practical advantage, as nine out of ten times the machine has to be placed so it requires a special jack-shaft and I have always found it the best plan, when machinery was idle, to stop it as close to the lineshaft as possible, and not have moving parts on the machine.

The "Old Reliable" Cone Drive

Now for the "old reliable" cone drive. When I say "old reliable," I do not mean the old-fashioned cone which was small in diameter and of narrow face. I mean, as I stated in the original proposition, the double-friction back-geared cone, which can be made of large diameter and proper face, the two ratios of back gearing enabling a cone to be designed so the old small step is entirely eliminated. With this type of drive, twice the power can be delivered to the spindle as with the same size pulley on a geared drive.

While I realize that the geared drive can be constructed so that the size and speed of the pulley is practically limitless, the fact remains that all the designs on the market today, are fairly well within the range of the modern cone sizes, used on similar machines. Further than this, there is no limit to the power that can be obtained by the cone drive. The Alfred Herbert Co. of Coventry, England, has demonstrated this in some of its new design machines in which they use the cone running at a very high speed, as a driver, and use the double back gear, never using the direct cone speeds. Of course, this construction is simply a development of the old style drive with which we are familiar on Lincoln type millers and machines of that description, but this combination of the cone drive, will give more power than is required by any machine in the market to-day, and will give it with less friction loss; in other words, with greater efficiency than any geared head machine on the market.

As to the belt-shifting feature on the cone-driven machine, that can be easily eliminated with a belt-shifting device, and is eliminated without that device where the belts are of moderate width and length, by the operator. He does not have to stop his machine to make the changes and practically performs an instantaneous speed change. The ideal drive today is large cone diameters with not overly wide steps.

As an example of the drift of actual practice in this line, I would like to cite planers. In our shop we have used four different designs of geared speed devices on our planers, all of which have been uniformly unsatisfactory. We have recently noticed that a prominent planer maker has "dropped" to this condition and is going back to a cone for his cutting changes. There is also one of the best planer makers in the United States who has always used a cone variator. We also know a prominent boring mill manufacturer who has found that the most practical way to obtain speed changes is through a cone.

In these instances, it is not a question of original cone design. It has been a development in which the cone has actually been found to be the most satisfactory method of obtaining these speed changes. This has also been exemplified in feeds. For instance, take grinding machines. Brown & Sharpe Mfg. Co. and Norton Grinding Co. are both using cone belts on their feed changes, after both had experimented and tried out different forms of gear changes.

Effect of Belt Pull on Spindle

Now I will speak about the fallacy of the belt pull on the spindle. With the geared head machines, of course there is no belt pull on the spindle, but there is the gear pressure, which in slow speeds, is multiplied many times and is considerably more than the belt pull. Further than this, on a cone-driven machine, the belt pull is not a detriment, but a possible advantage. It simply serves to counterbalance the weight of the moving parts, namely the cone and spindle. In my machine tool experience, I have never heard of a lathe spindle wearing upward. We know positively from our experience with second-hand lathes, that the spindles are invariably lower than the tailstocks, so this would positively determine that the wear of the spindle is downward in spite of the belt pull.

It is an indisputable fact that in ninety-nine machines out of every hundred, the cone drive is capable of furnishing much greater power than is required for the machine as operated, that is, the machines of to-day are not worked to fifty per cent of their pulling capacity; if they were worked to capacity, it would be a mighty bad thing for the machine tool builders, and would be the means of "calling a great many bluffs," as we all realize that there are a great many guarantees made with the absolute knowledge that the machines cannot stand up to the work continuously, and after the first trial, there will be no attempt to continue production on the same scale, which simply proves that the excessive pulling power, in ninety-nine cases out of a hundred, is not a legitimate requirement. The purpose of machining to-day is not to make shavings, but to do accurate work.

I maintain that you cannot get as good average production with a geared machine as you can with a cone-driven machine. I realize that on certain jobs a saving in time might be shown on a geared machine, but if two shops, one equipped with double-friction back-geared cone machines and the other with all-geared-head machines, both under equally efficient management, were taken as examples, the cone drive shop would be found to produce more work, or to produce the same work at a much lower cost.

In summing up this matter we arrive at the following conclusions: The advantages claimed for the all-geared machines have not been obtained; there is not a single all-geared machine on the market to-day in which instantaneous speed changes are obtained, or the required number of speed changes, without a multiplicity of friction clutches; there is not a geared machine on the market in which proportionate efficiency is realized; there is not a geared machine on the market for which the maintenance charge is not greater than for the cone head machine; there is not a geared machine on the market which can be produced for anything like the same first cost.

For the cone-driven machine, we can get a larger proportion of speed changes than is permitted by the geared head designs; practically the same power at the cutting tool; eliminate vibration and excessive wear; and get a cheaper first-cost machine.

* * *

It is stated by Mr. William W. Bird in the *Journal of the Worcester Polytechnic Institute* that belts of single thickness will stand a stress of 60 pounds per inch of width with only occasional taking up and will have a fairly long life, provided the pulleys are not too small. The permissible stress for double and triple belts would be 105 and 150 pounds, respectively.

A FEW FORGING OPERATIONS

PRACTICE IN THE C. H. & D. R. R. SHOP, LIMA, OHIO

By ETHAN VIALL*

A number of interesting forging operations are to be seen in the blacksmith shop of the C. H. & D. R. R., in Lima, Ohio, not the least of which are those pertaining to the mak-

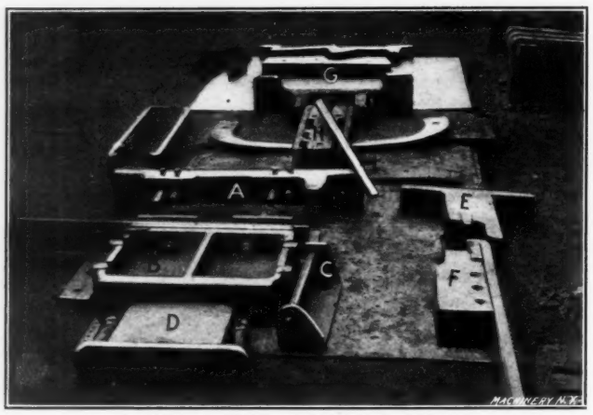


Fig. 1. Drawbar Pocket Forming Tools

ing of drawbar pockets; the bulldozer forming tools for making them and the various operations are illustrated in Fig. 1. The first operation after the bar is cut to length and one end heated, is to punch the four holes and bend the gib, which is all done at one stroke of the bulldozer ram, using the tools *A*

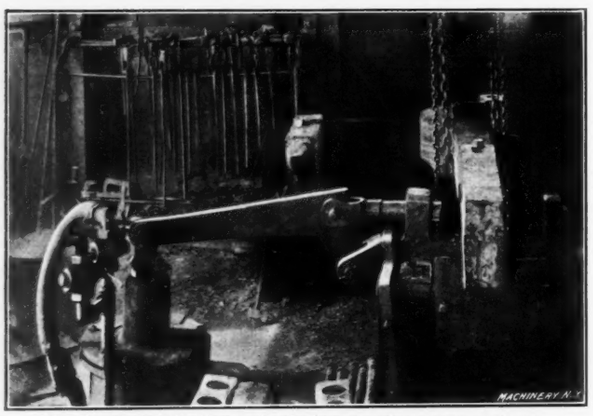


Fig. 2. Pneumatic Device for Setting the Rivets at One Stroke

and *B*. *C* is a stop for the stock, so made that it springs back out of the way as the end of the gib-former strikes it, and returns again to position as soon as released. The springs shown on each side of the member *D* are used to operate the strippers on the face of the punching die. Usually the end of

Fig. 3. Front View of Bolt Heating Furnace and Forging Machine

the gib is trimmed at the same heat and immediately after bending, using the trimming shears *E* and *F*. If a number of pockets are to be run through, they are all finished on one end in this way, by which time the ends of the first ones have been cooled enough to be handled easily, when the other end is heated and finished in the same manner. For several reasons it is not advisable to depend on stops to locate the middle of the pocket while forming the loop, so it is obtained by measurement, being marked with a chisel. The pocket is then bent in the forming punch and die *G* and *H*, in which it is located by means of the chisel mark just mentioned and a corresponding mark on the former, being clamped in position by an eccentric clamp operated by the lever *I*. It will be noticed that the former used here is solid and not of the wing type so frequently seen, and the results are just as good, apparently, as those obtained by using the more elaborate formers, no dangerous straining or tearing of the metal being noticeable. The pockets are riveted onto the drawbars by first heating the long rivets red hot, driving them home, and then upsetting the end in the pneumatic machine shown in Fig. 2. This machine is operated by an old air cylinder and the end of the upsetting plunger is cupped out to the shape required on the head of the rivet. In Fig. 2 a drawbar and pocket with one rivet in place, is shown resting on its side, held up by the chain hoist.

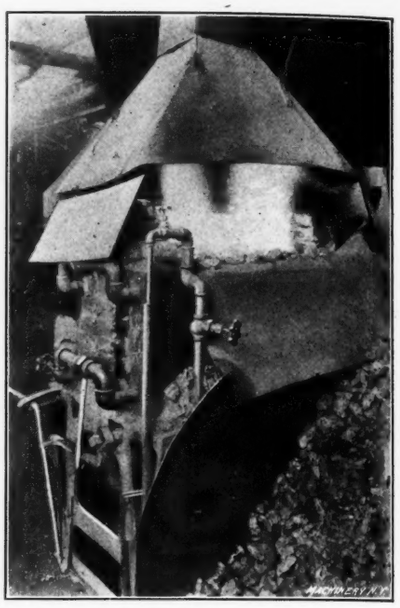


Fig. 4. Rear View of Water Jacketed Heating Furnace

The long rivets or bolts used for the foregoing job as well as other kinds, are headed in a regular forging machine fitted

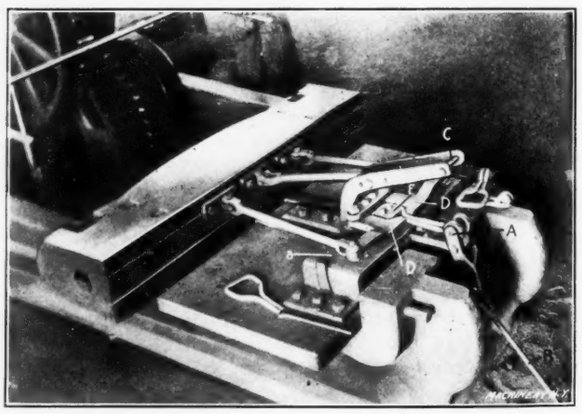


Fig. 5. Brake Hanger Former in Position at Forward End of Stroke

with suitable dies, the heating being done in the special coke burning furnace, shown in Fig. 3, which is the design of A. L. Woodworth, the blacksmith foreman, who is also secretary of the International Railroad Master Blacksmiths' Association. A rear view of this furnace is shown in Fig. 4. The furnace consists of a cast-iron frame 24 x 48 x 30 inches high to which is attached a blast box 12 x 12 x 48 inches long. This box is closed at the bottom with a door which fits closely to prevent the blast from escaping. At the top is a dump grate which supports the fire. This grate is level with the top of the frame and, when dumping, it swings down into the blast box. The top of the furnace consists of two cast-iron boxes, or water front and back, and these are 4 inches thick, 24 inches wide and 48 inches long, and are connected at each end with 1¼-inch pipe so as to allow a free circulation of

* Associate Editor of MACHINERY.

water, which keeps the furnace cool and comfortable for the operator. The front casting has a slot 3 inches wide by 36 inches long, left so that blanks may be fed in and heated for the bolts. This furnace is very satisfactory when coke is used for fuel.

Mr. Woodworth also designed a unique bulldozer attachment for forming brake hangers. This attachment is shown in operation in Fig. 5 forming the hangers similar to a large cotter. The rod is cut off to the desired length and then inserted between the stops at *a*. As the ram advances on its forward stroke the two wings or formers *D* bend the rod around the block *E*, forming the loop. A pin is then inserted

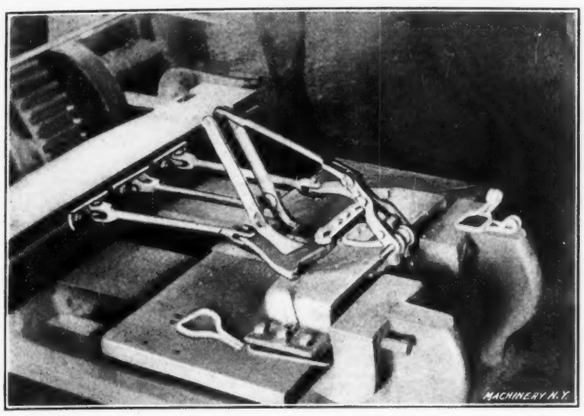


Fig. 6. Brake Hanger Former in Position at End of Return Stroke

at *A*, around which the second loop is formed, and the rod *B* connected to pin *C*. The slide is shoved in close and as the ram returns on the backward stroke, as shown in Fig. 6, it forms the loops on the end of the hanger. The pin at *A* is now pulled out, the slide pulled back and the finished piece removed, leaving the former ready for the next piece. It should be mentioned that these hangers are bent while red hot, of course. The working parts of this attachment shown fastened to the bulldozer are clearly illustrated in the line engraving shown in Fig. 7.

* * *

The increase in the sizes of warships is proceeding at a rapid rate. The English cruiser battleship *Lion*, which is now being constructed, will displace 21,000 tons and have a total length of 700 feet. The engines will develop 70,000 horse-

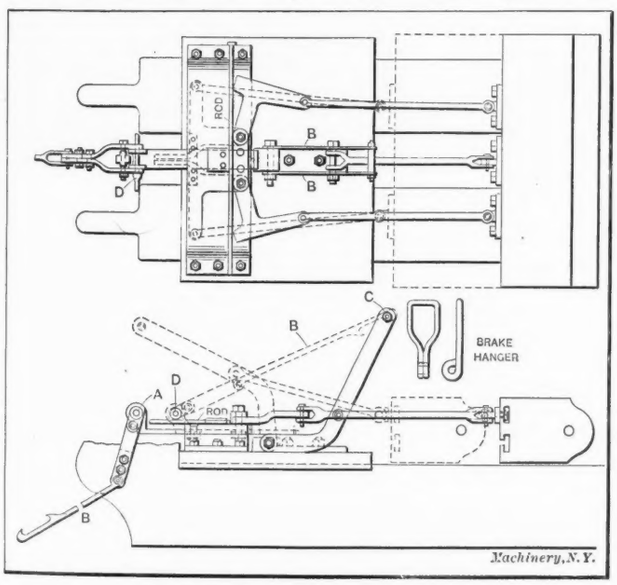


Fig. 7. Details of Brake Hanger Former

power. The speed of the vessel is expected to be twenty-seven knots and it will be equipped with ten 12-inch guns. As an example of the possibilities of engineering this battleship is a wonderful achievement, but from the point of view of the purpose of engineering it is one of the paradoxes of the age, because the purpose of engineering is to construct means for easy production—not for destruction.

PROPERTIES OF SECTIONS FOR PUNCH AND SHEAR FRAMES*†

By ALTON L. SMITH‡

The convenience of the tables of properties of rolled steel sections as published in the structural steel makers' handbooks impresses anyone who has occasion to compute the strength of such material. Machine frames cannot be standardized sufficiently to permit of similar tables which would be useful to the designer of machinery, but it is with a view to the simplifying of the work of selecting proper sections for punch and shear frames that the table in the accompanying Data Sheet Supplement has been compiled. The values were computed by slide rule, and it is believed that they are accurate enough for all practical purposes.

To illustrate the use of the table, consider the punch frame shown diagrammatically in Fig. 1. The "reach," or distance from the center line of punch to the back of gap, is 24 inches. Assume that the maximum pressure, *P*, tending to force the jaws apart is that due to punching a 1-inch circular hole in soft steel plate 1 inch thick, or say about 157,000 pounds. Consider the section at *TX*. The action of *P* is such as to produce a tensile stress on the section to the left of the neutral axis *N*, with a compressive stress to the right of *N*, both due to flexure; and, besides, there is a tensile stress distributed uniformly over the section.

It is usually sufficient to determine the maximum tensile stress to the left of *N*.

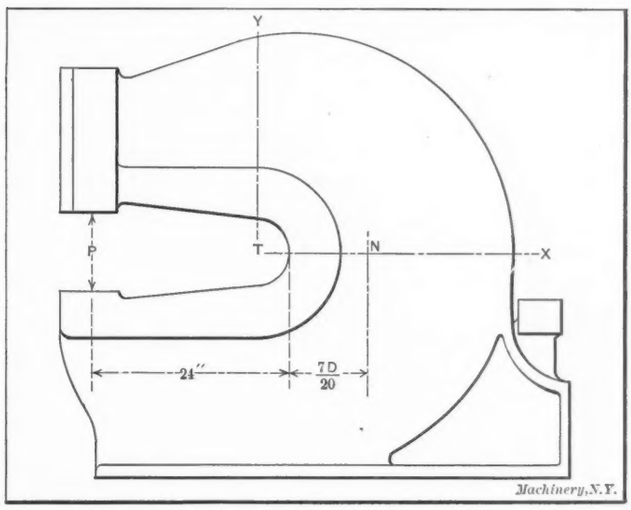


Fig. 1. Diagrammatical View of Punch Frame

Maximum tensile stress = flexure tensile stress + uniformly distributed tensile stress.

$$\text{Flexure tensile stress} = \frac{\text{Moment of } P \text{ about } N}{\text{Tensile section modulus of section } TX}.$$

$$\text{Uniformly distributed tensile stress} = \frac{P}{\text{Area of section } TX}.$$

Assume 3,000 pounds per square inch as the allowable maximum tensile stress for cast iron.

Trial Solution

Assume that *D* in Fig. 2 is about 30 inches. Then $\frac{7D}{20} =$ 10½ inches. If the stress due to flexure only is considered, the required section modulus for tension would be

$$\frac{157{,}000 \times (24 + 10\tfrac{1}{2})}{3{,}000} = 1{,}800, \text{ about.}$$

As no allowance has been made for the additional tensile stress uniformly distributed over the section, a section must

* With Data Sheet Supplement.

† The following articles on the design of punch and shear frames have previously been published in MACHINERY: "Design of Punch and Riveter Frames," November, 1905, engineering edition; "Strength of Punch and Shear Frames," February, 1907, engineering edition; "The Designing of Machine Frames," August, 1908, engineering edition; "The Design of Curved Machine Members under Eccentric Load," December, 1909, engineering edition. See also MACHINERY'S Reference Series No. 24, "Examples of Calculating Designs," Chapter II.

‡ Professor of Machine Design, Worcester Polytechnic Institute, Worcester, Mass.

be selected whose tension modulus is somewhat greater than 1,800, say about 2,500.

The table in the Data Sheet Supplement gives a great variety of shapes and proportions, the only dimensions common to all being the depth of section, D, and the distance of the neutral axis from the extreme tension fiber. This location of the neutral axis represents average practice and insures an economical distribution of metal. Generous fillets and rounded corners should, of course, be used on the final section.

Suppose that a deep narrow section is desired, similar to that in Fig. 2, in which the dimensions are as follows: $D =$ 10 inches, $B = 7$ inches, $b = 4$ inches, $H = 1.98$ inch, $\frac{t}{2} = h =$ $\frac{5}{8}$ inch, A (area) $= 26.3$ square inches, and S_t (section modulus for tension) $= 78.6$. This section of the table is not, of course, large enough, but a similar one which is large enough may be found easily as follows:

If two sections A and B are similar in all respects, then

$$\frac{\text{Area of } A}{\text{Area of } B} = \frac{(\text{Any dimension of } A)^2}{(\text{Corresponding dimension of } B)^2}, \text{ and}$$

$$\frac{\text{Section modulus of } A}{\text{Section modulus of } B} = \frac{(\text{Any dimension of } A)^3}{(\text{Corresponding dimension of } B)^3}.$$

$$\frac{\text{Required section modulus}}{\text{Modulus of section from the table}} = \frac{(\text{Required } D)^3}{(D \text{ of section from the table})^3}$$

Hence, $\frac{2{,}500}{78.6} = \frac{(\text{Required } D)^3}{(10)^3}$. This last equation solved for D gives $D = 31.7$ inches, nearly. As the large section will be exactly similar to the small one, the area of the large section is found from the equation

$$\frac{\text{Area of required section}}{26.3} = \frac{(31.7)^2}{(10)^2}$$

and area $= 264$ square inches, about.

The neutral axis will be $\frac{.7}{20} \times 31.7$, or 11.1 inches from the extreme tension fiber.

This trial section may now be tested for the maximum stress on it.

$$\text{Flexure tensile stress} = \frac{157{,}000 \times (24 + 11.1)}{2{,}500} = 2{,}200$$

pounds per square inch, about.

$$\text{Uniformly distributed tensile stress} = \frac{157{,}000}{264} = 594$$

pounds per square inch, about.

The total tensile stress is, therefore, 2794 pounds per square inch.

If this result had not been near enough to the 3,000 pounds per square inch assumed, another section could have been selected and worked out in the same way to get a closer result. The depth D of the required section being 31.7 inches as compared with 10 inches of the similar section given in the table, each of the dimensions of the required section will be 3.17 times the corresponding one given in the table. Hence $D = 31.7$, say 32 inches, $B = 22.2$, say 22 inches, $b = 12.7$, say 13 inches, $H = 6.3$, say $6\frac{1}{2}$ inches, $t/2 = h = 1.98$, say 2 inches. The webs thicken gradually from the neutral axis to the tension flange so as to avoid too sudden a change in the section. For selecting the section at TY, Fig. 1, the procedure would be the same except that there would be no uniformly distributed stress to be added as in the case of section TX.

The method here given for determining the stress on the section TX is the one which has been commonly used. It is correct for straight beams and until recently has been considered approximately correct for curved beams. Investigations by Bach and others, however, indicate that the maximum stresses in curved beams of ductile material are very much greater than those found by the method used here; but a quick and accurate way of applying the new theory to general sections has not yet been devised. Cast-iron punch frames whose sections have been determined by the old analysis have apparently stood up under their loads for years, although the maximum stresses in them as determined by the new analysis are so great as to threaten serious injury. [See article by Prof. Rautenstrauch in the Journal of the

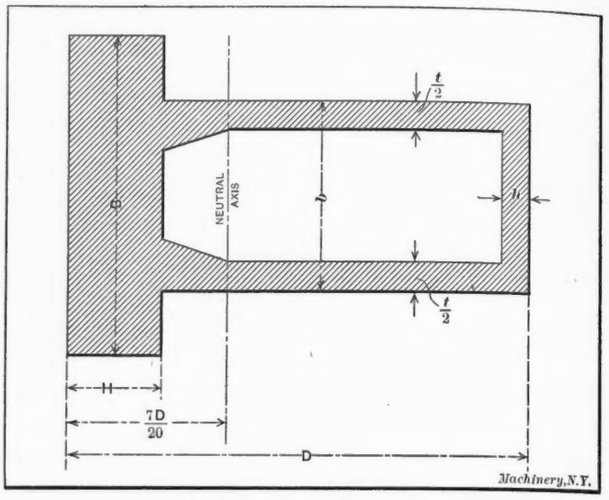


Fig. 2. Section of Punch Frame

American Society of Mechanical Engineers for mid-October, 1909. See abstract in MACHINERY, December, 1909, engineering edition: "The Design of Curved Machine Members Under Eccentric Load."] Until the new theory has been more thoroughly verified by experiments, however, the old method will doubtless be used by most designers.

* * *

CANCELLATION OF ORDERS*

By C. WOOD WALTER†

There is no force so potent in the manufacturer's daily "struggle for existence" as the machine-tool order. We are all smiles on a "big-order day," full of optimism after a "big-order month," and ready to enlarge our plant, increase our force, and bring out a new line after a "big-order year"—all of which would show good judgment if orders always turned into shipments—but there are times when they do not. It does not take a long memory to go back to the fall of 1907, when orders vanished from our books like a beautiful dream, and (to quote the immortal bard) "like an unsubstantial pageant faded into thin air." Our fat order books shrank into nothingness—almost over night—and instead of being six months behind on orders, as we were wont to boast, most of us, in about sixty days, got six months ahead. As a result we were obliged to cut down the working force and increase the costs, thereby cutting out profits. This deplorable condition was due to the fact that the demand fell off, but it was also largely due to the fact that many of the orders on our books were not contracts, but simply *guesses* as to what the buyers *thought* they *might* need.

There are two classes of orders, so-called, in the machine-tool business:

1. Orders from the machine-tool dealers for stock. This kind of order, when not limited, does not have a high degree of validity—and perhaps necessarily so—for no manufacturer should force his agent to take stock when the agent's sales do not justify his previous estimate. In so doing we are simply using the agent's money, thereby crippling our selling department and increasing the costs of marketing our goods. The agent's stock order is not good business—stocks can be more economically and more intelligently carried and maintained by the manufacturer at one central point in his warehouse than by his agents in their expensive stores at various points. This is not inconsistent with the policy of carrying a proper line of sample machines on the agents' floors. Agents' stock orders, for the most part, serve only to record the agent's judgment as to what the future demand may be in his

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†Address: Cincinnati Milling Machine Co., Cincinnati, Ohio.

territory. Many manufacturers, therefore, no longer accept agents' stock orders. Where they *are* accepted, it should be for limited quantities only, and they should be made not subject to cancellation.

2. Orders from the actual purchaser, the user of the machines, placed with the dealer or with the manufacturer direct. Many manufacturers are coming to regard this as the only order that is truly significant. But even this order, as commonly understood, falls short of being an actual contract. A large percentage of machine-tool buyers, to-day, place their orders with the mental reservation that they can easily meet a change in their plans, or a change in the market demand, by a cancellation of the order any time prior to shipment date. To some extent this cancellation privilege has been written into the order with the sanction of the dealer, or against his protest. To some extent the dealer has encouraged the buyer to reserve machines, subject to cancellation, and such reservations have been turned in as orders to the manufacturer who forthwith proceeds to invest his money to fill "the large orders on his books." I do not speak of the cancellation based on failure to deliver or on any legitimate grounds.

Now it does seem as though the machine-tool order as it exists to-day, might most profitably be subjected to a reform, so that it shall represent a contract, not subject to cancellation—the option of granting a cancellation to rest entirely with the vendor. The time to work this reform is now, while the demand is strong and there is no anticipated decline in sight. Consider what an added stability would be given to our industry to-day, if the unfilled orders on our books represented actual contracts not subject to cancellation! Consider what a change such a condition of our order books would have made in the fall of 1907, when the slump struck us—and yet this is just what an order means in many other lines of business. Why not in our line?

Let us review a few of the evil results that follow from the present practice of filling our books with so-called orders which do not represent binding contracts:

1. The manufacturer invests his money in materials and wages to finish machines on order, only to find when they are finished, that he may not have orders for them.

2. The manufacturer increases his production schedule to keep pace with his big order book. When his order book suddenly collapses under wholesale cancellations, he is left with a big stock on hand and coming out, with consequent heavy interest charges and often with heavy contracts for materials which he himself cannot cancel. This situation forces him to curtail immediately and run on a losing basis. It is bad enough to suddenly strike a market where new orders are scarce, without having to face a wholesale disappearance of the orders on hand.

3. Manufacturing on the basis of an artificial demand (as reflected in an artificially padded order book) makes also an artificial demand for material and labor, and a consequent increase in their cost. This is equally true for the dealer, who pays out his money to sell the goods, and increases his salesman's wages because the salesman is piling up big sales—which finally may largely disappear under cancellations.

4. Most disastrous of all, these wholesale cancellations under a slump in the demand, leave the manufacturers with such an over-production on hand, that the stability of prices is immediately and most seriously threatened. It becomes a matter of self-preservation for the weaker concern to cut prices. It is a matter of credit to this organization, that a disastrous and demoralizing break in prices did not follow the wholesale cancellation of orders and cessation of buying in the fall of 1907. This was prevented largely through the educational propaganda carried on by this association among its members to arouse them to a study of the real cost of the manufacture and sale of machine tools, and the right of every manufacturer to a decent profit beyond that cost—if he is to perpetuate himself in the business.

But our industry should not be subjected to such a strain as this. Once a demoralizing break in prices of this kind takes place, it takes years to recover. Now it is my opinion that we will take a long step in the direction of preventing this possibility, if we will cut out the cancellation privilege. Consider some of the benefits which would follow the establishment of the practice that would make a machine tool order not subject to cancellation.

1. The manufacturer may make his contracts for materials, arrange his manufacturing schedule, regulate the growth of his plant, with an actual knowledge of the amount of his product which he has absolutely sold, and which will stay sold.

2. The machine-tool dealer or agent may proceed with the development of his business, with the definite knowledge that he has earned so much profit based on his sales already made, instead of facing the possibility of a threatened and finally absolute loss when he is confronted with a flood of cancellations.

3. If the manufacturer can regard orders as actual and absolute sales, he can then intelligently and economically govern the amount and variety of stock he shall make, since he may approximately measure the actual and real demand for his various items of product.

4. Under a slump in the demand (which in the beginning is often more or less artificial), the orders remaining on the books, if actual and collectable, may be sufficient, in the whole industry, to bring about at least a partial resumption of business and restoration of confidence—at least the manufacturer would have time to reorganize his production without the disaster of sudden and drastic curtailment. This same benefit would accrue to the dealer as well.

Perhaps the simplest manner in which to bring this about, is for the different groups of competitors in this association to agree together to notify their agents that, beginning with a certain date, all orders on the manufacturers' books, and all orders to be entered in the future, must be considered "not subject to cancellation." This makes it possible and reasonable for the dealer to insist upon the same conditions from the consumer—and the consumer will find that he is asked to meet a regulation which is only reasonable and economic, and which is presented to him by all dealers and manufacturers alike, and he will soon yield to it as an established custom of trade, and ask in turn the same conditions of those who buy from him.

* * *

MAKING AN AUTOMOBILE STEERING WHEEL

By M. E. DAWSON

The steering wheel on an automobile, to the average person not familiar with the building of the entire machine, appears as only a drop in the auto manufacturing bucket, and yet if this small part of the automobile were manufactured in a shop by itself, the shop would be considered quite a large plant.

A section of the steering wheel ring on one of the leading makes of automobiles is shown in Fig. 1. The arms, center hub, and outer ring comprise the spider or metal portion and to this spider is secured a wooden ring of mahogany or other suitable wood. This wooden ring is "built up" and finished in two separate sections, each section having four segments. In the wood portion of this steering wheel only the best mahogany is used, and high-grade aluminum is used in the metal spider. The finished wheel must go through a critical inspection; defective material or workmanship, bad joints, "dutchmen," putty fillers, etc., are all causes for the inspector to put his blue-pencil mark on the wheels. In order to reach this stage of perfection in the construction of the wheel, and to turn them out in numbers sufficient to meet the requirements, every detail piece of work is done by special tools. I will not attempt to show more than one of these special-built tools, but from this may be learned to what extent this special tool building is carried on.

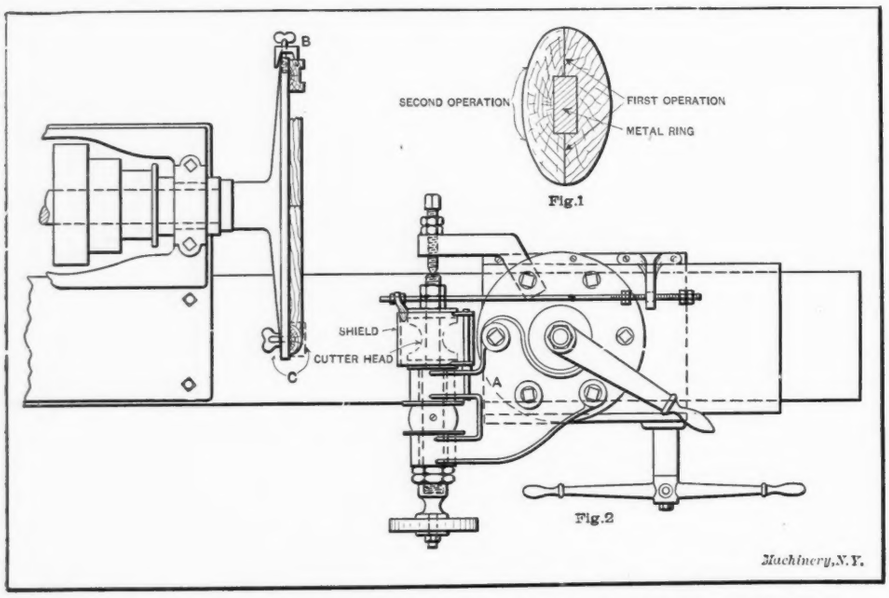
In the plan view, Fig. 2, is shown a reconstructed turret lathe, having an attachment for shaping the hand ring, a half of which is shown chucked on the faceplate. No change whatever is made in the tailstock or rather the turret head; the headstock, however, is set over so as to bring the center line of the stock to be turned in line with the center of the turret head. The cast-iron bracket *A* has two bearings which support the cutter spindle of the attachment. The cutter head consists of two steel collars—one butting against a shoulder

and the other loosely mounted on the spindle. Between these collars are clamped the cutter knives by means of the set- and lock-nuts as shown.

The cutter spindle is driven by quarter-turn belt, running over a deep-flanged pulley on the overhead countershaft, which is the same shaft that drives the lathe. The driving pulley on the countershaft is so located that the belt becomes tight as the cutter spindle approaches the work and loose when it is drawn away, thus relieving the constant high tension on the bearings, which saves wear and tear on both the bearings and belt. An emery wheel attachment is mounted on the end of the spindle and is a part of the lathe outfit. So as not to interfere with the movements of the operator, the emery wheel spindle is removed when it is not in use.

The first operation on the rim includes facing the joint and cutting the rectangular recess in which the metal rim of the wheel fits. The work is held during this first turning operation by pinch dogs, such as are shown at *B*; during the second operation on the opposite side, the rim is held by screws *C*, which pass through the faceplate and into the wood. The cutter spindle revolves at a high rate of speed, while the faceplate revolves more slowly, the speed being in proportion to that of the cutter spindle. The cut is gaged by collars on the cutter spindle, which come against the faceplate.

In Fig. 3 is shown a detail of the shield or cover which is over the cutter-head. This shield is automatically operated by the reciprocating action of the turret carriage, through the medium of a rod which is attached to the shield and passes through a stationary bracket as shown. When the cutter is at work, the shield is held in a position clear of the faceplate, and at the same time it directs the chips away from the operator. The shield is hinged, and on top of it there is an arm having a slotted hole through which the lifting rod passes. This rod, as indicated, is threaded to provide for adjustment. When the operator is in the act of removing the finished rim from the faceplate, it is impossible for any part of his person to come in contact with the cutter, owing to the protection of the shield.



Figs. 1 and 2. Section of Steering Wheel and Turret Lathe fitted with Special Turning Attachment

* * *

An interesting optical instrument has been introduced in Paris. It is made in the form of a walking stick provided with optical devices which enable a person to look over a crowd, the hats of ladies, fences, walls, etc. The stick consists of a hollow tube near the top of which is mounted half of a small field glass. The rays of light pass through the lenses and strike a prism inside of the stick, by means of which they are reflected at right angles to another prism at the lower end where they are again reflected in a horizontal direction, so that the objects open to the view of the field glass can be clearly seen by the eye.

OPERATION AND CONSTRUCTION OF THE SUB-PRESS DIE*

By ROY PLAISTED†

When constructing a blanking die, the class of work for which it is intended and the amount required should determine to a great extent the cost of the tool and the degree of accuracy necessary. Where only a limited number of blanks are required and a variation of a few thousandths is allowable, a die can oftentimes be made very cheaply that is good enough; for instance, in the manufacture of cheap jewelry

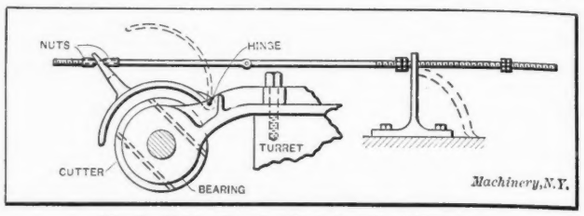


Fig. 3. Cutter Guard with Automatic Adjustment

where only a few thousand blanks of a certain kind are wanted, a die of cheap steel, three-eighths thick, soldered to a plate and run with a soft punch, meets all the requirements. On the other hand, on a class of work where accuracy is the essential feature and the die is in constant use until worn out, the best of material and workmanship is necessary. In shops where this class of work is handled, the sub-press die is usually depended upon to produce it. A die of this type is shown in the accompanying engraving. It is doubtless familiar to many of the readers of MACHINERY, as dies built upon this principle have been extensively used in nearly all the watch factories in this country for several years, and are constantly growing in favor in most shops where high-grade dies are used, though as yet they are not in general use to the extent that they would be if the many advantages to be derived from their use and the saving that could be effected were better known. It is true that the first cost of a die of this kind is considerable, but the long life of the tool and the excellence of its work make it a profitable investment.

A brief description of a sub-press die for producing the blank shown at *A* follows: The upper half of the casting or cylinder *B*, is shouldered onto the base *C* to which it is attached by screws *D*; it is also doweled in position by the two pins *E*. The plunger *F* runs in a casing of babbitt shown at *G*, the wear in which is taken up when necessary by screwing down the tightening nut *H*, which forces the babbitt down and in at the same time, as the cylinder is bored on a slight taper. The plunger has three semi-circular grooves milled along its length to prevent its turning. Attached to the plunger is the die *I*, which cuts the outside of the blank, and the small punches *J* which are held in the back-plate *K* and supported by the shedder *L* which is backed up by the heavy spring *M* the tension on which is obtained by screwing down screw *N* which has a small hole running through it to allow

* For additional information on the subject of punch and die work see MACHINERY, August, 1904, "Punches and Dies for Making Hinge Springs for Novelty Boxes" and "Notes on Die Making"; July, August and September, 1906, "Punch and Die Work"; July, 1906, "Progress in Simple Press Work"; October, 1906, "Blanking and Piercing Dies for Washers"; December, 1906, engineering edition, "Sub-press Work at the Sloan & Chace Shops"; February, 1907, "Making Blanking Dies to Cut Stock Economically"; March, 1907, "Construction of Split Dies for Press Work"; March, 1907, "Helpful Hints for Toolmakers"; May, 1907, "Sectional Punches and Dies"; June, 1907, engineering edition, "Novel Ideas in Die Making"; October, 1909, "Drawing Dies for Hollow Rivets"; January, 1910, "Die Beds or Bolsters for Presses"; April, 1910, "Automatic Punch Press Work"; June, 1910, "Out-of-Date Die Making Methods." See also MACHINERY's reference series pamphlet No. 6, "Punch and Die Work"; No. 13, "Blanking Dies," and No. 26, "Modern Punch and Die Construction."

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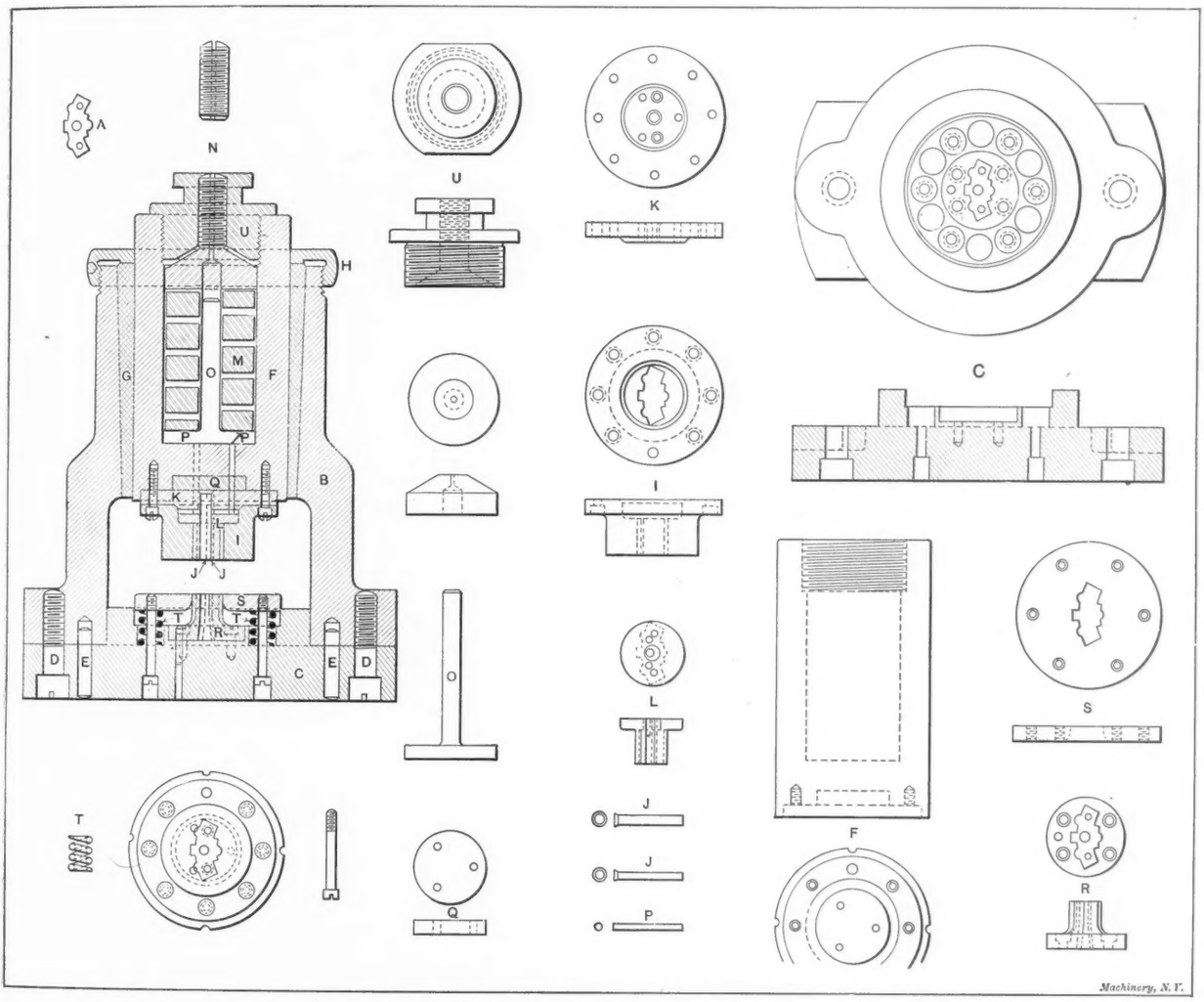
the air to escape. The center piece *O* and the three pins *P* placed between the spring and shedder, supply the tension necessary to operate the latter. The hardened disk *Q* is pressed into the plunger behind the back-plate as indicated, to take the thrust of the small punches. The base *C* is recessed to receive the base of the larger punch *R* which has three openings for the three small punches *J*, clearance being provided to allow the scrap punchings to pass through. The stripper in the lower member is shown at *S*, the resistance from the springs *T* doing the work.

In operation the plunger descends with the ram of the press and the stock caught between the two flat surfaces is held firmly in position at the time it is struck, thereby preventing any creeping or distortion of metal during the blanking. The outside of the blank and the pierced holes are cut simultaneously. Upon the return stroke of the ram, the tension from the small springs *T* forces the stripper *S* back over the punch *R* which still has the blank pressed firmly against its face by the shedder *L*, forcing the blank back into the scrap which is left smooth and flat, a feature which is appreciated wherever the reel-feed is used.



Assembled and Detail Views of the Type of Sub-press Die used in the Elgin Watch Factory for High-grade Work

The many advantages of this type of die over the open die are apparent to anyone seeing it in use. The fact that the sub-press is a self-contained tool, being in nowise dependent upon the ways of the power press in which it is run, and the consequent ease with which the die can be set, means a great saving in time, as all that is necessary is to attach the cap *U* to a T-slot in the gate of the ram, clamp the base to the bed of the power press, and adjust the stroke. Not only is it a time-saver, but it also possesses another distinct advantage in that it does not necessitate a careful lining up of punch and die, as dies of this kind are always in perfect alignment. This makes it impossible to set a sub-press die up so as to "shear" it, a feature which should not be overlooked, as usually this part of the press work is entrusted (through a mistaken idea of economy) to an inexperienced operator who has a very vague idea of the cost of the tools he is setting and to whom the shearing of a die is only a part of the day's work. Another point in favor of the sub-press is the fact that owing to the small punches being supported nearly their entire length, it is possible to pierce smaller holes in comparatively thick stock, than can be accomplished with any other die, it not being unusual to successfully punch holes in stock considerably over twice the diameter of the punch. A narrower bridge can also be left between blanks and a much better blank obtained than with any other form of die. The blanks are not only free from burrs, but they are always of a uniform size, the die being straight instead of having clearance, as is the case in the open die (where the blanks have to pass through) so that the first blank punched is an exact duplicate of the one produced when the die is worn out, which, obviously, means a longer life for the die.

In constructing the die shown, the sub-press stand should not be slighted, as upon its construction depends in no small measure the proper working of the die. If the stands are well made, they can be used indefinitely for different dies, owing to the means provided to adjust for wear. It is a disputed point whether the plunger should be babbitted before or after the punch and die are fitted. Some prefer to make the punch and die first, enter the punch into the die attached to the plunger, and pour the babbitt, but it is generally conceded that the better way is to babbitt the plunger first; in fact, most manufacturers at the present time buy them already fitted up from one of the several companies manufacturing them for the trade. One advantage in having the plunger babbitted first is that it can be run continuously for a day or so to free it up well and secure a good bearing, the large nut being set up occasionally. In this "working out," the

plunger is sure to creep a trifle, probably caused by the babbitt not flowing evenly and, obviously, it is much better for this change to take place before the alignment of the punch and die. In recessing the cylinder to receive the base, the proper way is to place the plunger on the centers of the lathe with the cylinder attached and recess and face out on the bottom, using the plunger for a mandrel. With this method one has the assurance of knowing that the plunger is exactly central and in a vertical position with the base, which cannot be said when the plunger is babbitted last.

In milling the three grooves in the plunger, it is well to space them unevenly, as it will then be impossible for the aforementioned press operator or anyone to insert it in any but its proper position. In locating the holes in the back-plate and shedder, a round master plate is usually used, thus insuring greater accuracy. This master plate can be laid away for duplicating the die. In boring the holes in the master plate, they should be made a trifle larger than the largest hole in the work, which gives clearance for the boring tool to pass through. When boring the back-plate, it and the master plate should be set perfectly central with each other and then fastened with a drop of soft solder on opposite sides. Having done this, a taper pin is inserted in the center of the faceplate of the bench lathe, and turned up on the end that projects, to the size of the holes in the master plate. One of the holes in the master plate is then wrung onto the pin, after which the master plate is clamped to the faceplate and one of the holes bored. No further indicating is required, as it is simply necessary to change from one hole to another upon the pin until all are bored. The holes should be left small, so as to correct the error from hardening, by grinding.

When grinding, the work is placed upon the master plate in the same manner and position as when boring, the grinding being done by means of a steel lap several thousandths smaller than the hole, the enlarged end of which is charged with diamond dust. [This process is more fully described in Mr. A. L. Monrad's excellent article in MACHINERY for December]. In separating the die from the master plate, the best way to remove the solder is to turn it off with a brass lathe tool before the work is removed from the faceplate.

When making the die *I*, great care must be exercised, as the die is straight and the templet must be worked through without any clearance; not only is this necessary for reasons before mentioned, but to allow an even sliding fit for the shedder. In case it is impossible to avoid a little clearance, it can sometimes be corrected in the lapping operation after hardening.

* * *

MEAN RADIUS OF THE FRICTIONAL FORCES OF A DISK BRAKE

By JOHN S. MYERS*

In the article on friction disk brakes on page 485 of the engineering edition of MACHINERY for February, the author assumes the center of tangential force to be at the center of gravity of the narrow sectors into which the disk may be imagined to be divided, while the editor inserts a note explaining that formulas have been found to give better results which assume the center of tangential force to be at the mean radius of the disk. As the writer has seen these two different ideas elsewhere, it was thought well to investigate the subject mathematically. The results confirm the statement as given by the editor. The assumptions upon which the investigation is based are as follows:

1. The coefficient of friction remains constant for varying pressures.

2. The wear of any one element of the surface is proportional to the work done upon it, *i. e.*, proportional to the pressure and velocity.

3. The disks remain flat under service, *i. e.*, they wear as fast at the outer edge as at the inner edge.

Assumption (1) would be far from true for conditions of perfect lubrication, but for slightly greasy surfaces such as those of a brake it is approximately correct. Assumption (2) would also be far from true for perfect lubrication, but seems reasonable for the ordinary conditions met with in disk brakes. Assumption (3) is almost self-evident, for, if one portion of the disk were to wear faster than another, it would be relieved of the load, thus equalizing the wear.

Let w = wear per unit pressure and velocity in unit time,
W = wear at any radius r,
N = revolutions in unit time,
P = pressure per unit of area.

Then $W = wP2\pi rN$ or $P = \dfrac{W}{2\pi wrN}$ (1)

Now, using in the following demonstration the methods of calculus, let dA = area of any ring having a radius r and a breadth of dr, r being variable.

Then $dA = 2\pi r dr$. (2)

and if dF = the pressure on this ring,

$$dF = PdA = \frac{W2\pi r dr}{w2\pi rN} = \frac{W}{wN}\,dr. \quad (3)$$

Let D = diameter of disk, then integrating (3) we have

$$F = \frac{W}{wN}\int_0^{\frac{D}{2}} dr = \frac{WD}{2wN} \quad (4)$$

Now let dm = the moment of the ring about the center; then

$$dm = rdF = \frac{W}{wN}\,rdr. \quad (5)$$

Integrating (5) gives

$$m = \frac{W}{wN}\int_0^{\frac{D}{2}} rdr = \frac{WD^2}{2wN4} \quad (6)$$

Now let R = the lever arm of the total force F; then

$$R = \frac{m}{F} = \frac{WD^2 2wN}{2wN \times 4WD} = \frac{D}{4} \quad (7)$$

which is the distance from the center of the disk to the center of gravity of the normal pressure on the disks. According to assumption (1), the coefficient of friction remains constant for varying pressures; hence the center of the tangential or frictional forces coincides with the center of the normal pressure as given by equation (7). The significance of equation (7) is, that for a complete disk the mean radius of the frictional forces is equal to the arithmetical mean radius of the disk.

Such disks, however, are seldom complete disks, but are annular rings in which the inside diameter is sometimes as great as half the outside diameter. For such disks let

D = outside diameter
D_1 = inside diameter,
m_1 = moment of the disk about the center,
F_1 = total normal pressure on disk,
R_1 = the lever arm of F_1 = also the mean radius of the tangential frictional forces.

From equation (6) we may write

$$m_1 = \frac{WD^2}{8wN} - \frac{WD_1^2}{8wN} = \frac{W}{8wN}(D^2 - D_1^2) \quad (8)$$

From equation (4) we may write

$$F_1 = \frac{WD}{2wN} - \frac{WD_1}{2wN} = \frac{W}{2wN}(D - D_1) \quad (9)$$

Then $R_1 = \dfrac{m_1}{F_1} = \dfrac{W(D^2 - D_1^2)}{8wN} \times \dfrac{2wN}{W(D - D_1)} = \dfrac{D + D_1}{4}$ (10)

Now $\dfrac{D + D_1}{4}$ is the arithmetical mean radius of the disk,

and hence unless the disks are working under conditions approximating those of perfect lubrication, they will wear in such a manner as to make the mean radius of the tangential frictional forces at least approximately equal to the arithmetical mean radius of the disk.

* * *

According to the *Brass World*, an aluminum alloy containing an average of 96 per cent aluminum, 2.5 per cent copper, 0.75 per cent manganese and 0.75 per cent silver can be rolled and drawn and is then much stronger than pure aluminum. The rolling may be done either hot or cold.

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GRINDING ECONOMY*

H. DARBYSHIRE†

Being one who is much concerned with grinding processes I was naturally interested in Mr. Thacher's useful contribution, "Economy in Grinding," in the May issue.

His remarks on the hints which are afforded by demonstrators being disregarded or forgotten by operators are to my own knowledge too true, but I would like to venture a friendly criticism on one point in his contribution which I trust he will receive in the spirit in which it is tendered. Mr. Thacher in speaking of spotting work off for steady-rest purposes seems to recommend it especially for hardened work, and if this is his general practice his experiences must be of a happier nature than my own or of those I usually encounter. As these experiences of his are a result of observations made in the works of the Brown & Sharpe Mfg. Co. we may assume that in this particular case it may be good practice and may be due to some special process of hardening or annealing.

It is, however, common knowledge that pieces of work which are hardened almost invariably contain internal

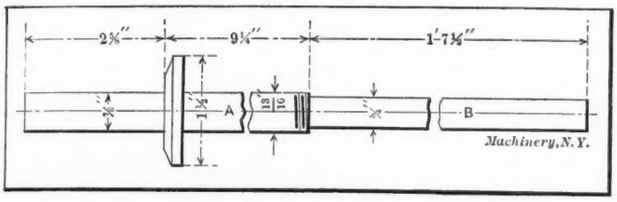


Fig. 1. Sensitive Drill Spindle which gave Trouble when ground after being turned in a Turret Lathe

stresses. To spot places off to within 0.001 inch of the finished size would mean disaster in general cases. Further than that it is within my own experience that this characteristic is not confined to hardened work but may be met with in soft pieces which have been machined by the more modern methods. I refer more particularly to work done on the modern turret lathe, and have found that pieces machined by this means are not to be relied on without a consistent previous rough grinding process over the whole surface. Cold-drawn material will display similar peculiarities, and the inference in both cases is fairly obvious. In the case of cold-rolled stock we may safely assume that the severe process it goes through in the course of manufacture is the cause of the trouble, and the pressure of the steadies in the bar turret lathe may very easily account for difficulties met with in grinding work which comes from the bar turret lathe. A case in point is the ordinary sensitive drill spindle shown in Fig. 1. I have had these spindles come from the engine lathe (made from forgings), and ground them without trouble; other batches which come from the turret lathe have displayed what I may term a devilish peculiarity. If I roughed down say portion *A* to within a finishing limit this portion would be some 0.003 inch out of truth when portion *B* was ground to size, or *vice versa*. In fact I found the only possible way was to rough off the skin in the first place on both *A* and *B*. With all due respect to Mr. Thacher's experience I think that economy in steady shoes is of less account than is quality and truth of work in the grinding machine. The real advantages of grinding might well be described as follows, in which will be used some of my previously written matter:

The gratifying advantages which may be obtained from the use of high-speed steel are limited to a certain point, that point being where a very small amount of material must be left and extreme care exercised in arriving at the precise dimensions. For this final finishing it may be claimed that the grinding machine is the most rapid and economical tool to use, for the following reason: It removes this small amount of material in the shortest comparative time; it arrives at the desired dimensions by a series of rapid and minute chips which cover the whole surface repeatedly and whose depth is under perfect control, any variation in its shower of sparks being constant and visible evidence of its change of form either through distortion or accident; and finally it allows of the actual surface finishing being the last operation, thereby removing all those errors and distortions which may be a result of hardening on other previous operations. The fact that a ground surface is superior to that produced by a file or water cut is indisputable, and the rapid manner in which a fixed dimension may be obtained is another recommendation; that the result is effected by a series of minute chips with a visible index of their depth is another point in its favor. In order to start a finishing cut in the lathe and control its size, the length of its traverse, in most cases, requires a sense of touch which may have taken years to attain; to obtain a similar result, but a better surface, in the grinding machine is a far easier matter because another of the senses is enlisted. Given a few days' practice with a grinding machine, an operator can judge to 0.001 inch the depth of cut he is taking by the shower of sparks displayed.

We are indebted to Mr. Thacher's contribution for some valuable time-saving hints which those who may adopt will find of some value, but there is also an economic side to the grinding question which he does not touch on and which may be well worth consideration.

In some six years' experience as a demonstrator of grinding processes, it has been my privilege either to work in or to have entry into most of the principal shops in Europe, and with a few happy exceptions I have not seen a grinding plant run on what I consider truly economic lines. Most of these places are factories where I have personally installed machines and have made special efforts to instruct and hustle operators into making time and, incidentally, getting a better quality of product than I produced myself. In a few instances, on revisiting these factories it has been my pleasing experience to find that the said operator has excelled both my own and his former efforts and is doing both my company and myself a service. This, however, is the exception rather than the rule and it may be profitable to consider some of the causes which may lead up to these deplorable exceptions:

The prime causes are the apathetic attitude of the supervision or the skepticism of the management which fails to recognize the advantages of the old saying that "what is worth doing is worth doing well," and so fail to give as much attention to a plant which, although a somewhat modern innovation, is certain to give large returns if properly handled. We live in an age where "time is money" and much valuable time may be lost on a grinding job with either improper gaging methods, the absence of gages or an absurdly restricted limit of tolerance.

Piecework seems to be a necessity, owing to a failing in human nature, for it is easier and fairer to pay a man for what he does than it is to get him to do what he is paid for. This being the case, it is as necessary on a grinding job as it is on any other, and to get the maximum output requires that the operator should be assisted as much as possible.

It is the duty of the demonstrator to prove that a given job can be done in a given time without superhuman exertion, and after this it is up to the shop supervision to see that the standard of efficiency is adhered to. Apart from speed this said standard of efficiency should be maintained by a careful system of gaging with as much limit as is compatible with the quality of work required, and for this purpose a system of limit or tolerance gages is admirable; those inanimate pieces of metal with their "go on" and "not go on" have to my own knowledge reduced the amount of bad language and ill-feeling which was prevalent in many shops. They do away with that friction between the grinding and inspection departments which comes from depending on the individual sense of feeling with the micrometer caliper. To be more explicit, an examiner may have the delicate sense of touch of a lady and the grinding operator that of a navvy.

I have mentioned the necessity of giving as broad a tolerance as possible, for it is quite apparent that if this be done the output of an operator may be materially increased; as an illustration of this I may cite a case which is still fresh in my mind. A few weeks ago a 6-inch by 32-inch Norton plain grinder was put in a local factory for the grinding of the valve stem shown in Fig. 2. The stems were made of a high quality of cast steel and were hardened with about 0.012 inch

* For previous articles on grinding see "Economy in Grinding," May, 1910, and the previously published articles there referred to.

† Instructing operator, Norton Grinding Co., 73 Broomfield Road, Coventry, Eng.

to 0.015 inch left on their diameters for removal by grinding. Now a valve stem is given a few 1/1000ths inch play, and it would seem as if a tolerance of 0.001 inch would be as fine as would be necessary. However, this particular firm is very nice over its work and bears a reputation for quality which is second to none in Europe and so it insisted on a limit of 0.00025 inch, + and —.

The slot on the radial end of the valve was very convenient for using a thumb nail driver on the catch plate of the grinder and 80 per hour were produced to the limits demanded. A 24 L alundum wheel of 2-inch face was used and the automatic cross feed was two teeth, or 0.0005 inch per stroke of table. The wheel would duplicate about 20 turns before losing its size but the rather fine limit required some extra care and judgment of the sparking towards the last chips. If the tolerance had been double that demanded it would have been easily possible to produce 100 per hour, for practically no gaging would have been required.

A little knowledge is proverbially a dangerous thing and it has been my own experience to be often tied down to limits so fine as to be absurd when the class of work was taken into consideration. It is generally those "rule-of-thumb" people

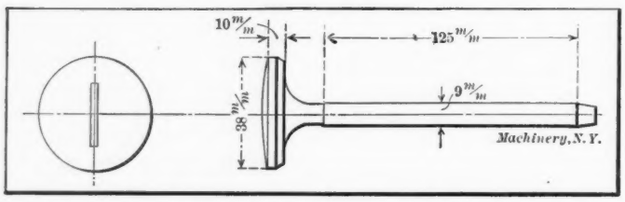


Fig. 2. Valve for Motorcycle Engine, Production of which was greatly reduced because of the Small Tolerance allowed

who make this mistake and in the fullness of their knowledge they despise all modern gaging methods. The first expense of installing a proper gaging system would seem to have terrors for them and the want of it may be costing them thousands of dollars per year. They ask for work of so accurate a nature that it may demand the patience and skill required for standard gage making and so limit the production of a machine as to make it painful to watch the operator who is tending it.

A great time-saving factor in the work of a grinding machine is the manner in which the work is prepared for the machine's reception; the modern grinding machine is undoubtedly a rapid stock remover and within certain limits will beat the lathe all hollow, but if some amount of judgment is not exercised in preparing work its full economic advantages may not be realized. It is, of course, impossible to lay down any fixed rule for grinding allowances, for these must depend on the shape and condition of the work, but I find that the leaving of an allowance of 0.015 inch to 0.030 inch on a diameter is the most economical for general work on a modern machine.

There are at the present time many engineers who are skeptical on the grinding subject and I suppose that until the end of time we shall have the old fogy element with us.

On the other hand there are those who are too optimistic and either expect too much or have mistaken notions as to the grinding machine's mission. Here is an illustration of how some little tactful suggestions proved of service in one of many parallel cases. A 20-inch by 30-inch by 168-inch Norton plain machine was installed in a factory, mainly for the purpose of grinding chilled rolls for the oil seed crushing trade. The rolls, Fig. 3, which were 16 inches face by 48 inches long came into the factory rough turned and were bored to the required dimensions; steel axles were afterwards forced in by means of a hydraulic press until they took the shape, when finished, as shown in the sketch. The principal of the firm was a smart business man and had a scheme outlined for a revised method of manufacturing these rolls which at first sight seemed quite reasonable. He proposed to turn the shafts to size for the press fit and leave 1/16-inch on the axle portion for finishing, which was to be removed by grinding. The first two experimental rolls were put through in this manner but they failed to clean up on the axle portion, this no doubt being due to distortion caused by the high pressure required for forcing in the axles and probably also some little error in alignment of holes in the rolls; the roll portion also took an excessively long time to grind. It was proposed to the principal that in the future he have ¼ inch left on the axle portion and that after forcing in he have them recentered true with the roll portion and a rough turning cut taken over the ends, but with a perseverance worthy of a better cause he proposed to adhere to his method, but to leave 3/32 inch on the axle ends; this was done for the next pair of rolls and as a guarantee had been given with the machine the time test was taken. This guarantee, by the way, was to grind a roll and axle ends complete in 2 hours, removing 1/32 inch of material from the diameters. In spite of the excessive amount (3/32 inch) left on the axles, two rolls were ground complete in 3 hours 50 minutes, this including getting out the fillets with wheel turned to shape. Since this incident occurred, the principal of the firm, being a reasonable man, has recognized that his scheme did not work out profitably and acting on suggestions offered he now prepares his work in the following manner:

He turns the axles to size for the press fit but leaves ¼ inch on the end portion; they are afterwards centered true by gripping one end in a chuck and running the roll portion in a fixed steady; the axles are then turned to within 0.030 inch of size. By following this scheme he is enabled to save some 60 per cent of the grinder's time and a similar amount in his annual cost of grinding wheels.

There is a little matter connected with a grinding plant where serious losses often occur and when the reasons for what I may term a mistaken idea of economy are analyzed it resolves itself into an absurdity.

In this I am referring to the provision of diamonds which are a necessity for the truing of the grinding wheels. I have seen some grinding plants where there have been from 20 to 40 operators at work and it has been the rule to provide one diamond truing tool for some five or six operators. There would, in these cases, seem to be an impression that something is saved by restricting the supply of these apparently expensive but necessary tools. It would almost seem as if the word "diamond" has some cabalistic qualities and that its weight compared with its price is a kind of bogy to men who are otherwise sane.

The question resolves itself into this: If five men have the use of one diamond tool, the said tool is likely to have the

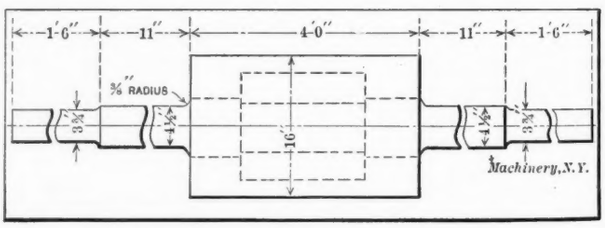


Fig. 3. Chilled Roll for Oil Mill that made Trouble in Grinding until Procedure in Operations was changed

wear and tear of five tools and so far there is nothing gained by this parsimony; on the other hand there are likely to be some losses which may easily occur and perhaps be unnoticed. A wheel may become glazed and so be somewhat ineffective until the diamond is applied. Here the individuality of the operator will display itself; he may have that "tired feeling" and prefer to put up with the defect in his wheel to his employers' loss rather than search amongst his mates for it. Another class of operator is so socially inclined that he may be unable to make this search without having a few seconds' chat with each of those he inquires of as to the diamond's whereabouts; if five men have the use of one diamond tool no one can be truly made responsible for it if it gets lost, and when this does occur the whole plant is inconvenienced and delayed until it is replaced. Another point to consider is that if only a single diamond is allowed to five operators it will get dulled more rapidly. Now a dull diamond has caused and still causes endless trouble and losses in a grinding plant. It is responsible for much of the skepticism which exists on grinding matters generally, and like all other cutting tools it should be kept in the proper cutting condition.

MACHINE SHOP PRACTICE*

CHIPPING

The finishing of surfaces by chipping and filing is practiced comparatively little to-day, as the improved tools now in use have largely eliminated such work, though at times even in a modern shop it is necessary to resort to the hammer and chisel, particularly in erecting and general repair work. To reduce a plain surface by chipping, requires considerable skill which can only be acquired by practice. A few general suggestions, however, will doubtless be of value to anyone who desires to become proficient in this particular work.

The various types of chisels commonly used for chipping are shown in Fig. 1. The flat chisel *A* is used for a general class of work. The cutting edge *e* is either ground straight for light work or made slightly convex for heavy chipping to prevent the corners from breaking. The angle at the end should be about 60 degrees, though a greater or less angle is advisable when the metal is either exceptionally hard or soft. A cape chisel is shown at *B*. This has a narrower cutting point than the flat chisel, and is used principally for cutting grooves, etc. The side chisel *C* differs from the flat type *A* in that it is ground and beveled on one side only, which permits it to be used on surfaces which could not be reached with a double-angle end; it is also used for chipping the sides of keyways, slots, etc. The diamond point shown at *D* is adapted to chipping V-grooves, squaring corners, etc., while the grooving chisel *E* is for cutting oil-grooves or for similar work. The half-round chisel *F* is known as a gouge, and, as its shape indicates, is used on curved surfaces.

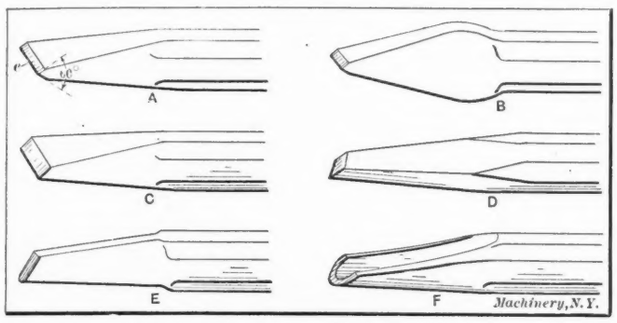


Fig. 1. Different Types of Chipping Chisels

Most workmen who are not accustomed to chipping, proceed very awkwardly, principally because of fear of striking the hand, and in order to avoid this, the eyes are continuously fixed on the head or striking end of the chisel. It is not necessary, however, to look directly at the chisel head in order to hit it, as a little practice will show, but it is important to continually watch the cutting end, as the chip being removed determines whether the chisel should be raised or lowered to increase or decrease the depth of the cut. The hand holding the chisel should be quite close to the striking end to obtain better control, and it is well not to grip the chisel shank with the thumb and forefinger as an accidental blow on the relaxed muscles will be less painful than when the chisel is gripped tightly by the entire hand.

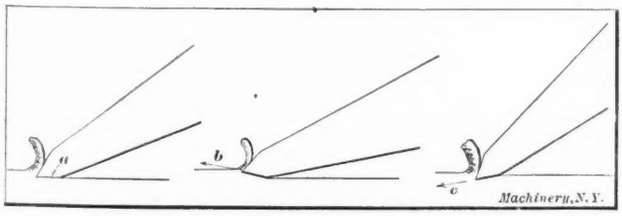


Fig. 2. View showing how Depth of Cut is altered by Position of Chisel

The way in which the position of the chisel alters the depth of the cut is illustrated in Fig. 2. As each successive blow is struck, the chisel tends to move along the plane of the supporting surface *a*, so that lowering the striking end causes the point to move upward, and raising it has the opposite effect, as illustrated by the arrows *b* and *c*.

When it is necessary to reduce a broad flat surface by chipping, a number of grooves *d* of uniform depth are usually first cut across, as illustrated in Fig. 3, and then the metal remaining between these grooves is removed by a broader chisel of the flat type. By this method, the broad chisel cuts more easily as there is no resistance at the corners and sides. It is advisable before chipping a surface that needs to be carefully finished, to chamfer the corner where the cuts end (as at *f*) to prevent the stock from breaking out below the depth line.

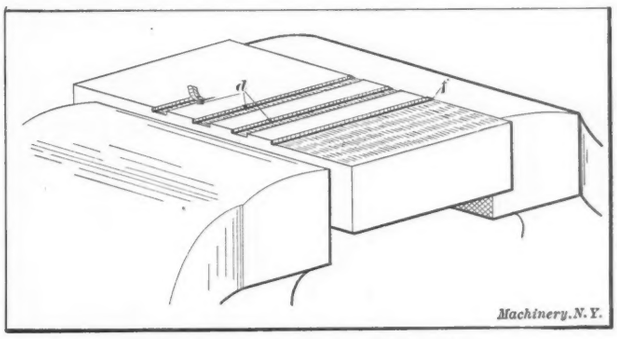


Fig. 3. Method of Chipping a Flat Surface

Whenever there is considerable chipping to be done, a pneumatic hammer, a type of which is illustrated in Fig. 4, should be used if one is available. The chisel, with the shank inserted in the hammer, is held in the left hand and the hammer with the right. By manipulating the lever *l*, the admission of air to the cylinder and consequently the speed of the hammer blows is regulated. The small flexible hose through which the air is supplied is connected at *h*. When beginning a cut, the hammer should be started gradually so that the movement of the chisel may be more easily controlled. Both hammer and chisel should be held firmly against the work and at an angle which will depend on the depth of cut desired. When the hammer is working at full speed, the cutting movement of the chisel is almost continuous, owing to the rapidity of the blows. This continuous cutting action makes it possible, of course, to take a smoother cut and to work more rapidly than is possible by hand chipping. The pneumatic hammer is also widely used for riveting, beading boiler flues, and for many other kinds of similar work. When used for these various purposes, special tools are, of course, employed.

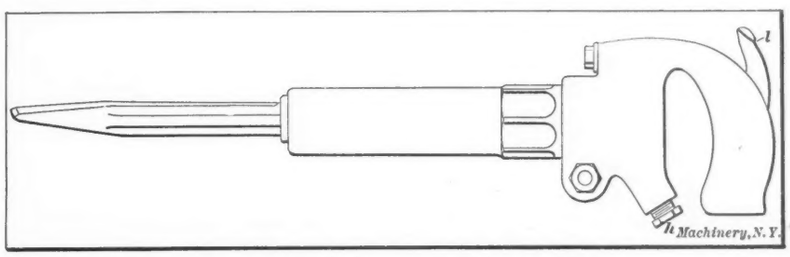


Fig. 4. Pneumatic Hammer arranged for Chipping

* * *

The German Consul-General at Budapest reports to his government that, owing to the large demand for metal working machinery and metal goods in Hungary, the home factories cannot keep pace with the orders. He states further that the Hungarian Parliament, therefore, has decided to build five machine tool works, which will employ 860 men, and that arrangements have also been made for the erection of twenty other works and foundries which will employ from 4,000 to 5,000 men. It would appear from these reports that Hungary would, at the present time, offer a good field for machine tools.

* With Shop Operation Sheet Supplement.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

TIPPING SHOP TOOLS WITH HIGH-SPEED STEEL

In no shop that I have been in is the practice of using small pieces of high-speed steel to tip tools made of an inferior grade of steel carried out to a greater extent than it is in the shop of Wm. Barker & Co., Cincinnati. Mr. Barker makes lathe, planer and shaper tools and special drills, by using machine or a low grade of carbon steel for the body and making the cutting edge of a small piece of high-speed

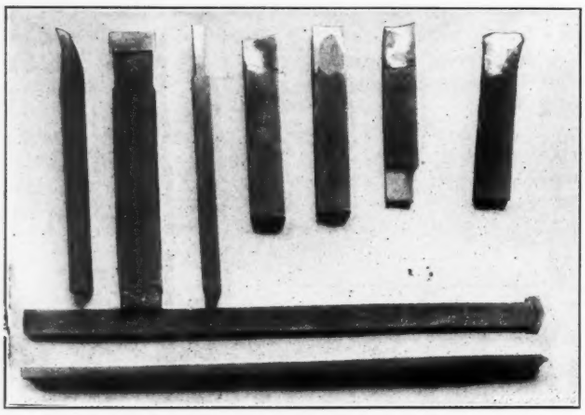


Fig. 1. Lathe and Planer Tools, and Spindle Drills tipped with High-speed Steel

steel "brazed" on. Of course, nothing original is claimed for this, as it has been done in many railroad shops and other places for some time, but Mr. Barker has carried the idea farther than is usual.

In Fig. 1 are shown a number of lathe and planer tools and two long drills used for drilling out lathe spindles, tipped in this way, while in Fig. 2 are four drills, a lathe tool, and a wide channeling tool for the planer, which is tipped on each end of the crosspiece with a cutter. In tipping a tool with high-speed steel, the piece should be so fitted that a close union is made when brazed. It will be noted that the drill tip is fitted into a slot in the end of the bar, and it is usually a good plan to pin the tips in place on the other tools,

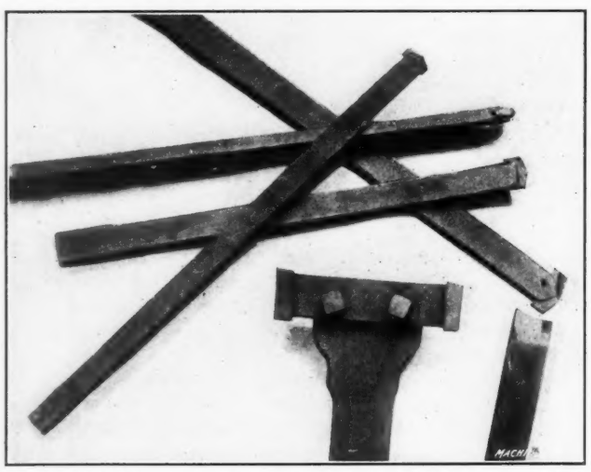


Fig. 2. Spindle Drills and Large Double-tipped Channeling Planer Tool

with a small pin, so that they will not slip out of position while in the fire. Ordinary brass spelter is not suitable for high-speed steel; copper should be used instead, with borax as a flux. A convenient way to obtain good copper for brazing is to take a small piece of electric wire, scrape off the insulation and file a small slot in the recess of the tool for it to lie in. Brazing is, of course, done in the usual way except that the heat should be higher. Tips put on tools in this way will stand considerable rough usage without coming off; in fact, if the work is well done one has trouble loosening a piece with a hammer, if one cares to try the experiment.

Cincinnati, Ohio. ETHAN VIALL

METHOD OF MAKING BLUE-LINE PRINTS

In the May number of MACHINERY a process by which blanks can be printed on blueprint paper, giving as a result blue lines on white background, is described. I desire to submit an entirely different and simpler method which I have made use of, that will doubtless interest draftsmen and office men in general.

All the material necessary is a sheet of some ordinary grade of carbon paper, a No. 6 or 8 drafting pencil having a blunt, smooth point, a blank sheet of common typewriter paper, and a smooth, hard drafting-board or table.

After the desired form or sketch has been carefully laid out and all the lettering finished lightly in pencil on the blank sheet, place the carbon paper with the carbon side upon the table. Then lay the blank paper (with sketch up) on top of the carbon and after fastening both to the table with thumb-tacks, proceed to trace the sketch with the hard pencil, being careful to press quite hard and uniformly as the lines of the sketch are followed.

By examining the carbon it will be found that wherever lines have been drawn, no matter how small a letter or figure was made, a good impression was reproduced on the face of the carbon. The latter may then be used the same as a tracing

MONTHLY-REPORT

Gasoline Consumption at Charging Stations Automatic Signals.

Section No. ___ Month of _____ 19__

	Gals. Gasoline in Tank.				Gals. Used	
	Oper. Battery		Trk. Battery.			
	Beginning of Charge	End of Charge	Beginning of Charge	End of Charge	Oper. Battery	Trk. Battery.

A Blue-line Print made by using Carbon Paper as a Negative

to print through. It should be exposed from 2 to 3 minutes, according to the speed of the paper used, and after the latter has been washed out thoroughly, the desired result will be accomplished.

Carbons prepared in this manner, which I have been using for some time, appear to be as good as when made. In order to save time in printing, several carbons can be made from the original sketch or by tracing over prints. By placing these in a large printing frame, a number of blanks can be printed simultaneously on one large sheet. By filing these carbons in indexed envelopes or between indexed sheets, they will last almost indefinitely and will be convenient to get when needed.

The accompanying engraving shows a fair sample of the prints produced by this method. A. G. PANCOST

Elkhart, Ind.

CLEARANCE SPACE OF GAS ENGINE CYLINDERS

In designing the cylinders of a gasoline motor, one of the first things to determine is the volume of the clearance space. In order to find this, the compression which the motor is to have must be known. In automobile motors the compression varies all the way from 60 pounds to 100 pounds per square inch gage. The formula most generally used for finding the clearance space is:

$$\frac{p_1}{p_2} = \left(\frac{v_2}{v_1}\right)^n \quad \text{or} \quad p_1 = p_2\left(\frac{v_2}{v_1}\right)^n$$

where p_1 = compression pressure in pounds, absolute,
p_2 = initial pressure,
v_1 = volume of clearance space,
v_2 = total volume of cylinder (piston displacement plus clearance space).

The value of n given varies from 1.21 to 1.41. This value of n varies with the engine speed, valve timing, valve diameter,

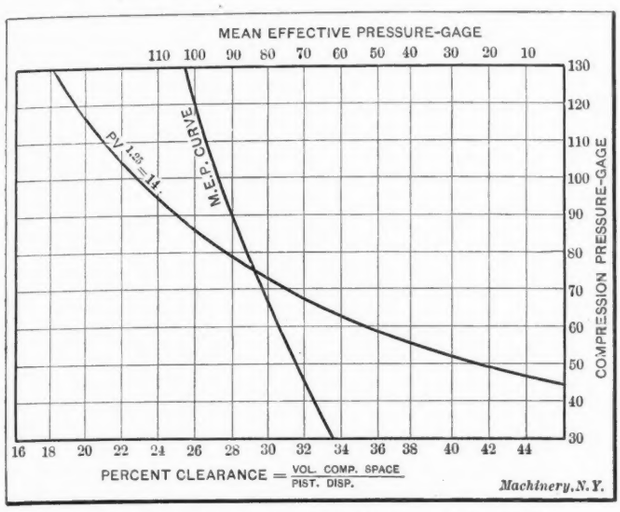

MEAN EFFECTIVE PRESSURE-GAGE
110 100 90 80 70 60 50 40 30 20 10
130 120 110 100 90 80 70 60 50 40 30
COMPRESSION PRESSURE-GAGE
M.E.P. CURVE
PV 1.25 = 14
16 18 20 22 24 26 28 30 32 34 36 38 40 42 44
PERCENT CLEARANCE = VOL. COMP. SPACE / PIST. DISP.
Machinery, N.Y.

Chart for Determining Percentage of Clearance Space in Gas Engine Cylinders

valve lift, size and shape of the inlet pipes, and temperature of jacket walls. It will be seen from this that the compression cannot be calculated exactly, since it depends on so many variable quantities. It has been found by making tests of a number of gasoline motors that a value of n=1.25, when the initial pressure is 14 pounds gives very close results.

Using this value the accompanying diagram was plotted. To find the percentage of clearance for a given compression, find the compression in pounds gage in the column at the right, and follow across to the compression curve, thence to the bottom of the diagram where the percentage of clearance is read.

To find the mean effective pressure for a given compression, take the compression in the column to the right, as before, and follow across to the M. E. P. curve, thence to the top where the mean effective pressure is read.

These curves give values which come very close to the average for automobile motors.

HERBERT C. SNOW

East Cleveland, Ohio.

PLAINER LETTERS AND FIGURES IN THE DRAFTING-ROOM AND SHOP

I agree with Mr. W. S. Rowell in his statement in the May issue of MACHINERY regarding the importance of plainer letters and figures in the drafting-room and shop. In our shop we have met with difficulties common to all in arranging our standard style of figures, and as the above writer has expressed a wish to have this matter discussed in your columns,

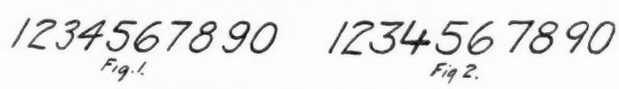


Fig. 1. Fig. 2.

the benefit of my experience in this subject may be of interest to your readers.

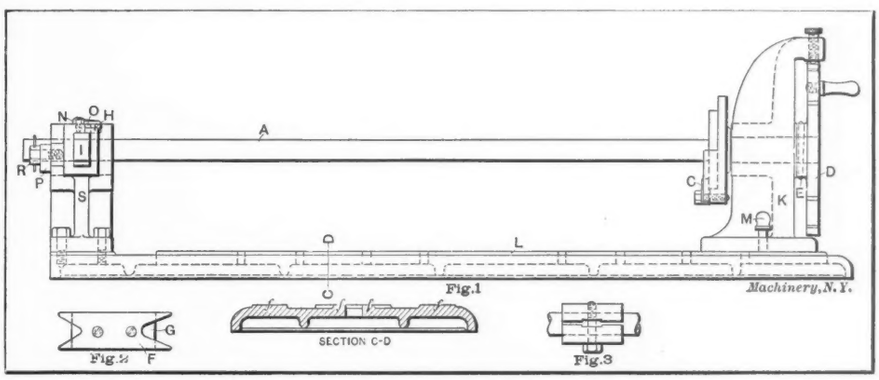
Each man in our drawing-room, previous to the introduction of more modern methods and standardization in the drafting department, was allowed to use whatever style of letters and figures he was most proficient in. This, in itself, tended to confuse the workmen in the shop, and a standard style, as illustrated by Fig. 1, was adopted, and religiously adhered to. This style, we thought, was just about the "real thing," being in our estimation the easiest to make and the plainest set of figures we could adopt. When carefully formed, the figures, as illustrated, show clearly and unmistakably on original drawings and tracings, but we soon found that due to occasional blurring of blueprints in spots, the figures were not so easily distinguished on the prints. The first common mistake discovered was the taking of 1 for 7. To remedy this, we simply added a small projection to the horizontal line of the 7, as shown in Fig. 2. The second difficulty was caused by the 3 and 8, which was overcome by changing the shape of the 3 as shown. The next step was to change the 9, making it with a straight tail to avoid confusion with the 6 and 0. After these changes had been made, we thought we had a practically "fool-proof" set of figures, but we found that some of the toolmakers persistently read the 9 with the straight tail as 4, so we were obliged to make the latter figure as used in ordinary writing, with the top open.

The result of our efforts is shown complete in Fig. 2, and, as finally adopted, this set of figures has been in use for several months with a surprisingly small number of mistakes. I believe the figures are hard to improve upon and might well be adopted by many firms.

DESIGNER

FIXTURE FOR LOCATING CAMS ON CAM-SHAFTS

An inexpensive fixture by means of which cams may be quickly located on their shafts for drilling and reaming the taper pin holes, is illustrated in the accompanying engraving. All the cams are placed in their relative order on cam-shaft *A* (Fig. 1) which is attached to the dividing-head shaft



Figs. 1 to 3. Fixture for Locating Cams on Cam-shaft

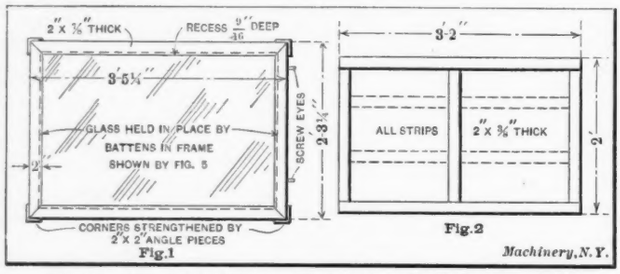
by a clamp *C* as shown. Cam stop *F*, Fig. 2, is milled out to receive the exhaust cam on one end and the inlet cam on the other end. The plate *G* is to hold the cam in the proper position for drilling, under the bushing *H*. The stop *F* is inserted in the slot *I*, after which the dividing head *K* is moved along on the table *L* to the first division, which is located by the pin *M*. *D* is the dividing plate with which a pin engages to locate the cam-shaft at the proper angle. After drilling, the latch *N* is moved to one side, and plate *O* is removed so that the hole can easily be reamed. A lock *P* with a recess in the center the size of the cam-shaft is provided to support the shaft while drilling and reaming the holes. The end of this supporting piece is dropped down by loosening screw *R*, the other end being on a pivot; after the next cam is located for drilling, *P* is replaced. This fixture may be used for milling keyways in cam-shafts by replacing the casting *S* with one having a slot in the top as shown in the plan view, Fig. 3.

C. G.

A CONVENIENT BULLETIN-BOARD

In presenting the work in machine drawing at the Worcester Polytechnic Institute it has been found very desirable to have a place in which references and data may be posted for the student's use. Blueprints, MACHINERY's data sheets and numerous other data can thus be posted from time to time as

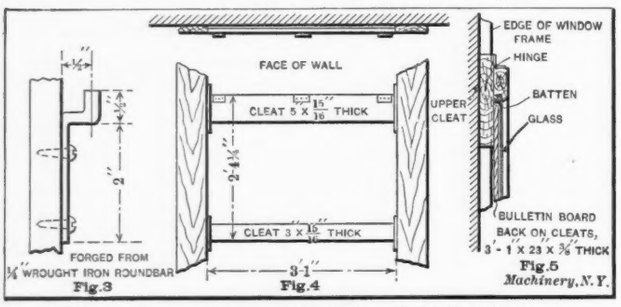
various lines of work are taken up. Bulletin-boards are used for this purpose, being placed about the drawing-room in the open spaces between the windows. As these boards were originally made they were rather inconvenient, it being necessary to remove them from their fastenings on the wall when it was desired to take out or put in new material. The original form of the board is shown in Figs. 1 and 2. The frame was supported by means of screw hooks and eyes. The back-board



Figs. 1 and 2. Original Form of Bulletin-board with Improvements

shown in Fig. 2 (solid lines) was held in a recess cut into the back of the frame, by means of buttons. It was made up of 2-inch by ⅜-inch strips, covered with canvas. The prints or drawings were pinned or pasted onto the canvas.

The question then arose concerning the best and least expensive plan for the alteration of these frames. After some thought the changes were made as shown by Figs. 1, 2 and 3. The corners of the frame which holds the glass were strengthened by 2 inch by 2 inch angles. The supports shown by Fig. 3 were substituted for the screw hooks, and four additional strips were put into the back-board (shown by dotted lines)



Figs. 3, 4 and 5. Improvements which made the Bulletin-board more Convenient

to be used for receiving thumb tacks. The back-board was then hinged to the supported end of the frame.

One of the frames was changed as shown by Figs. 4 and 5. The chief advantage of this frame over the others is the solid white pine back-board, and the cost for making the changes was much greater. The drawing shows the frame supported from above, but it could be supported at the ends just as well.

Worcester Polytechnic Institute. JAMES C. DAVIS

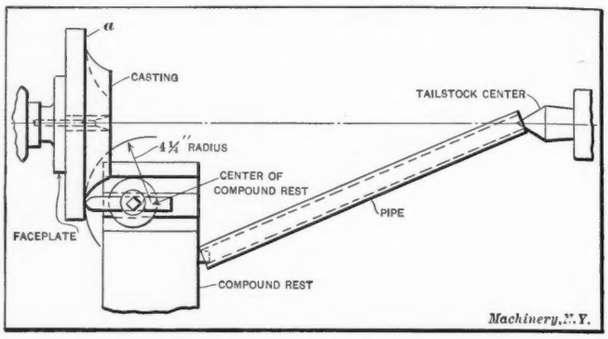
METHOD OF PREPARING TRACING CLOTH

It is a well-known fact that neither the glossy nor the dull side of tracing cloth takes ink readily without being prepared in some manner. The usual way is to sprinkle powdered soapstone or chalk on the tracing cloth and rub it over the surface with a piece of cloth. This helps somewhat, but not enough to be perfectly satisfactory. After trying various methods, I have found a way which gives excellent results, and that is to sprinkle the powdered soapstone on the cloth as usual, but rub it in with a blotter instead of with a piece of cloth, using a circular motion and considerable pressure; of course it is necessary to brush away the superfluous powder. The use of a blotter has an abrading effect and it is just harsh enough to give the cloth a surface which will take the ink readily and still leave the pens unharmed. I find it to be an advantage to repeat this process each morning in case the tracing is not finished the day it is started; the rubbing of the blotter over the lines already inked in does absolutely no harm and, if anything, makes the lines more dense. A trial will convince the draftsman that the cloth will take the ink better by this method, than by any other.

Chicago, Ill. ROBERT A. LACHMANN.

TURNING A RADIUS WITH A COMPOUND REST

The accompanying illustration shows a method of turning a radius on wheels which were used for centrifugal pumps. These castings were larger than the standard size; and having only a few of these and as in all probability we would never have an order for a larger quantity, it was thought impractical to make a special fixture for machining them. The following method was used: The wheels were bored and faced on each side and the part at *a* turned parallel to the starting point of the radius. A small drawn-in chuck was then used for holding the castings tightly against the faceplate, as shown. The two bolts used for keeping the compound rest from revolving were released just enough to allow it to revolve freely, and the tool set in the tool-post at right-angles to the faceplate, and at a distance out from the center pin of the compound rest, equal to the radius required on the casting. The carriage was then fastened to keep it from moving. Then one of the screws which was used to hold the gib in the compound rest was removed and a stud inserted in its place. A length of pipe, as shown, was then placed on



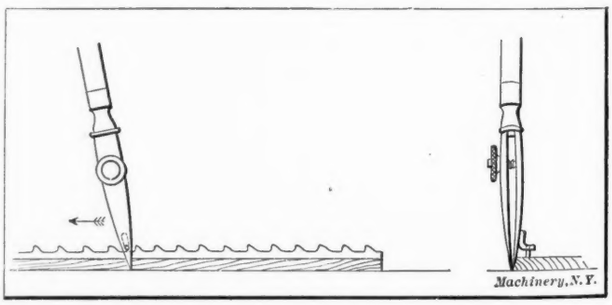
Turning Radius on Centrifugal Pump Casting

this pin and on the tailstock center. By bringing out the tailstock center, the pipe forces the compound rest around in a radius, turning off the superfluous stock and producing the correct radius on the piece. 1/64 inch was left for finishing and after all the castings had been roughed out they were then put on again and the finishing cut taken.

Toronto, Canada. JACK E. HAILSTONE

A SIMPLE DOTTING ARRANGEMENT

The illustration shows a dotting device which the writer uses in place of the expensive wheel and other dotting pens which are sold. The advantage of this is its cheapness, and the fact that either dotted or full lines can be drawn without any change whatever. A little rack with a series of rounded



Pen Attachment and Rack for Drawing Dotted Lines

teeth is attached with cement or other adhesive to the face of a straightedge or T-square, a little way back from the edge. On the back of the inner pen blade a small piece of brass is soldered, with its end turned at right angles to lie parallel with the face of the straightedge. This brass pin is set to such a height that when the pen is tilted over, about as illustrated, the pin just clears the bottom of the grooves in the rack, consequently permitting the pen to ink on the paper. In use, the pen is moved along, keeping it at the angle shown, and the teeth cause it to jump up and down, producing a series of dashes on the paper. A dotted line can be drawn in this way as fast as a full one, and without any of the fatigue, and fidgetiness which is caused when one dots

in the usual manner. The pen should be held lightly, to let it rise and fall in an easy manner. By simply bringing the pen into a vertical position, the brass pin will clear the tops of the rack teeth, and a full line can then be drawn. Probably if a roller were fitted on the pin, the pen would work along the rack in an easier manner, but the writer has not tried this. The rack was made from a piece of hack-saw blade by reducing its width, taking out each alternate tooth, and rounding off the remainder to suitable outlines. Of course any form of dotting may be produced by shaping the teeth suitably.

FRED HORNER

Bath, Eng.

SPEEDS AND FEEDS FOR CARBON OR HIGH-SPEED TWIST DRILLS

To obtain the maximum cutting power and life from a twist drill it is essential that the speed and feed be adapted to suit the particular material being drilled. The accompanying charts give actual working speeds and feeds and represent good general practice.

In drilling, the aim should be to use moderate speeds and heavy feeds, as chips take a great deal less power to produce than powder. The rubbing action which takes place with fine feeds soon spoils the cutting edge. For drilling steel a good supply of lubricant should be maintained. Speeds and feeds should be reduced when drilling hard materials.

Birmingham, England. V. BROCKBANK

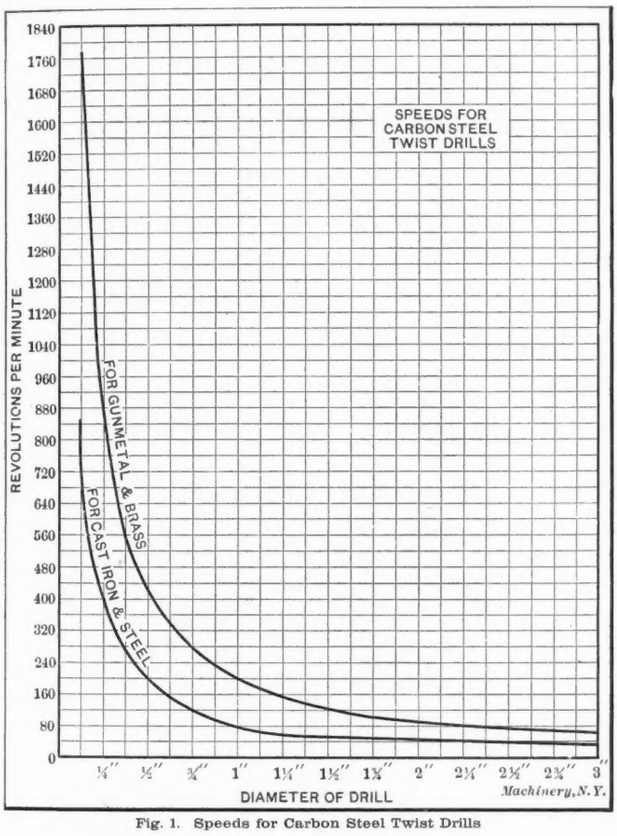


Fig. 1. Speeds for Carbon Steel Twist Drills

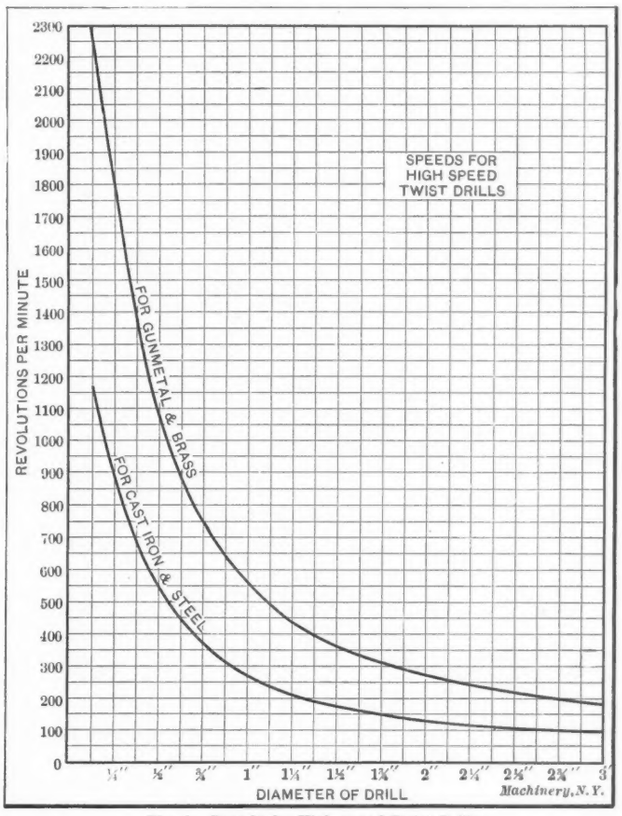


Fig. 2. Speeds for High-speed Twist Drills

A FIXTURE FOR STRADDLE MILLING

For straddle milling thin castings such as cabinet parts for adding machines, typewriters, etc., where there are no machine surfaces on which to clamp or locate the work, milling fixtures of a type similar to that herein described and illustrated may often be successfully used, as they are quickly operated, rigid in construction, and comparatively inexpensive. The fixture shown in the accompanying illustration is designed for use on a double-headed milling machine to straddle mill the two sides of a thin brass casting, and is constructed as follows: The base of this fixture marked *A* is a gray iron casting of the box type, suitably ribbed internally, and also externally, to give it the necessary rigidity, and provided at its ends with feet which have slots in them to receive the clamping bolts used in attaching the fixture to the platen of the milling machine. It is also provided on its under surface with two steel tongue blocks which fit into the groove on the milling machine platen, serving to align the fixture properly.

The casting *A* is machined on the top and bottom, and to its upper surface the cast-iron brackets *B* are fastened by means of heavy fillister head screws and dowels. These brackets are stiffened by suitable ribs, and are provided on their outer sides with dove-tailed ways, in which slide vertically the steel guides *C*, to the outside of which are attached the long clamp strips, *D*. These strips are of steel and are channeled on their lower edge for the full length of the strip, and into these channels are inserted heavy rubber pressure shoes, which serve to conform to the irregularities in the surface of the unfinished casting which is being clamped, and to hold it securely upon the tool steel resting strips *E*. In the center

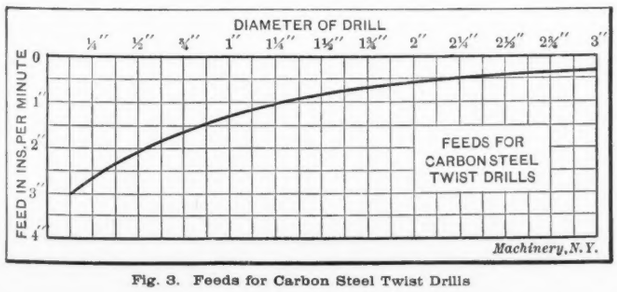


Fig. 3. Feeds for Carbon Steel Twist Drills

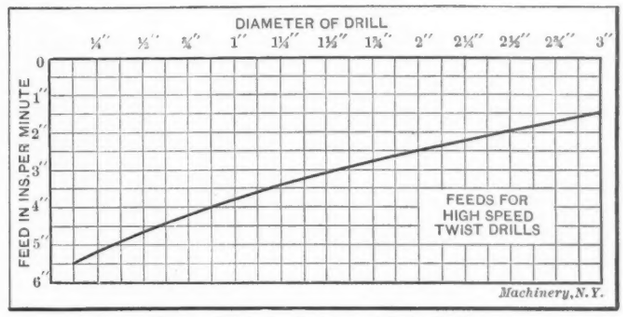
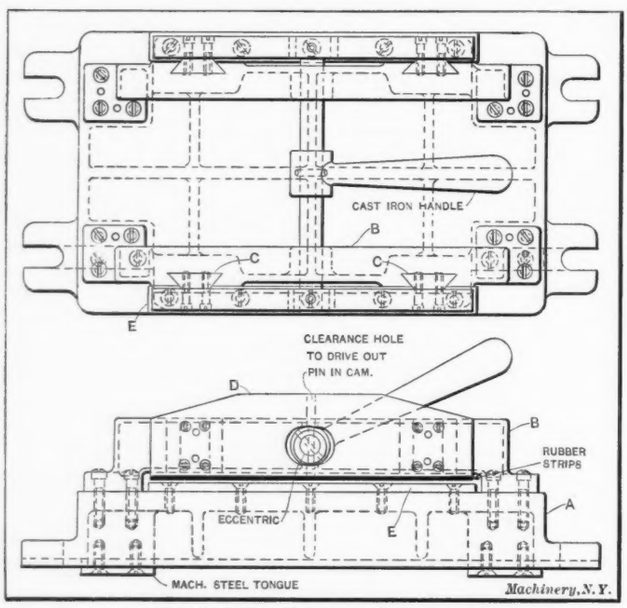


Fig. 4. Feeds for High-speed Twist Drills

of each of the clamp strips *D* are elongated holes in which operate eccentrics of hardened tool steel; these are attached to the end of a steel shaft which runs across the fixture and has a bearing in each of the cast-iron brackets *B*. To the center of this shaft is attached an operating handle of cast iron by which the clamping strips are depressed forcibly enough to secure the work; when at this position the eccentric is thrown over its dead center, retaining the clamps in their positions during the machining operation.

A modification of this fixture may be designed to be operated by compressed air instead of by hand, by making its general construction the same as the device shown in the accompanying illustration, but replacing the operating handle by a lever at whose extremity is a piston which operates in a suitable air cylinder, the air inlet and outlet of which are controlled by a small valve of the taper plug type, equipped with a small lever handle. This, of course, makes the operating of the fixture very much easier than by hand, and when the character of the work is such as to warrant the extra expenditure, this valve may be so located that it will be tripped by a projection on some part of the milling machine in such a manner that, when the machine platen returns after the cutting stroke is made, to a point where the work is out from under the cutters, the clamps will be automatically released, leaving the fixture in a loading position. It is then only necessary to place the work into position and throw in the power feed on the milling machine table, whereupon the air



Straddle Milling Fixture for Thin Castings

valve will be tripped, clamping the work before it reaches the cutters. Of course, these air operated fixtures can only be used in factories which are supplied with compressed air, properly piped to the various machines, but they are great labor- and time-savers, and where the character of the product will permit of their usage, the saving of time will soon pay for their cost. C. NOSRAC

ESTIMATING WEIGHTS OF ROLLED STOCK

To arrive mentally at the weight of round steel per foot of length without recourse to tables (which are not always at hand) it is sufficient to know that by squaring the number of quarter inches in the diameter of the bar and dividing the result by 6, the answer gives the weight in pounds per foot of length. Expressed as a formula this would be $\frac{(4d)^2}{6}$, where d = diameter of stock in inches of tool steel.

Anyone who wishes to work this out for a round machine bar with an area of cross-section of 144 square inches will find that it is based on 489 pounds per cubic foot. On ⅛-inch sizes like 1⅛-inch, for instance, it will be easier than squaring 4½ quarters to take even figures and say $4 \times 5 = 20 + (\frac{1}{2})^2 = 20.25 \div 6 = 3.375$ pounds per foot.

In dealing with large diameters and squaring the larger numbers, the method of squaring by the use of the nearest tens simplifies the procedure. For example, take 4½-inch round; 4½ = 18 quarters and in squaring 18 consider it as two less than 20. This difference of 2 from 18 leaves 16 for the other multiplier. $16 \times 20 = 320$, and adding the square of the difference which is $4 = 324 \div 6 = 54$ pounds per foot. For a proof to the eye of the correctness of this method of

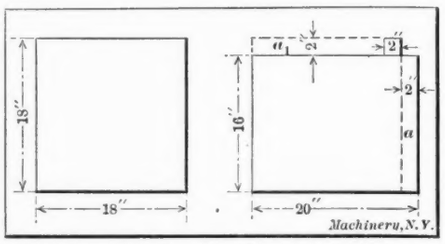


Diagram Showing Correctness of Squaring

squaring refer to the accompanying diagram; here the dotted position a of the rectangle would manifestly fit in at a_1, and complete the square.

Hexagon stock is about 10 per cent heavier than round; square stock, about 28 per cent heavier than round. It is, however, easier to get the weight of square or rectangular sections by multiplying the area per square inch of cross-section by 10, which will give the weight per yard of length. This is based on 480 pounds to the cubic foot, the weight of iron and a unit of length which was in common use when iron was generally used. "Weights per yard," however, have almost entirely disappeared except in connection with rails, and section books now give the weights of material in pounds per foot. The weight per foot is easily arrived at by taking 1/3 of the figures given above for iron and by adding 2 per cent for weight of steel.

The weight of sheet iron is found by using the number of thousandths of thickness considered as a whole number and dividing by 25 for the answer in pounds per square foot. Hence ⅛-inch plate = 125 thousandths ÷ 25 = 5 pounds. This, too, is based on 480 pounds per square foot and is 2 per cent too light for steel, which would then weigh 5.1 pounds in the above example. The result obtained by using a block 12 inches thick is

$$\frac{12 \times 1000}{25} = 480 \text{ pounds, for iron,}$$

To this add 2 per cent for sheet steel = 480 + 9.6 = 489.6 pounds.

By using the foregoing simple formulas one is entirely independent of tables and is equipped for work whenever it appears, without book aid in each case. ROBT. S. BROWN

New Britain, Conn.

DIVIDING A CIRCLE INTO EQUAL PARTS

In the May number of MACHINERY a method was given by Robert Wilkinson for dividing a circle into any number of equal parts, and readers were called upon for a geometric proof.

The method as given is neat and interesting, but it is an approximation and exact only for certain particular cases. There is no geometric proof for it. The line *AB* of Mr. Wilkinson's diagram is a method for spacing the diameter *LS* into a given number of equal parts, and is not a part of the problem. In the figure given herewith the diameter *LS* is spaced into n equal parts. Here $n = 5$.

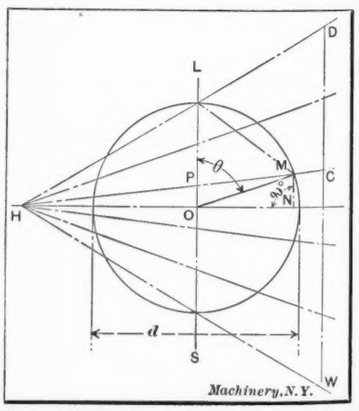


Diagram for Dividing a Circle into Equal Parts

The point H is located by describing an equilateral triangle on LS, making the lines LH and SH equal to LS and equal to d. The line HPM is drawn through the second division P; then LM is the desired nth part of the whole circle. A variation, perhaps an improvement, would be to draw the line DW. Extend HL and HS to DW. Space off the distance DW and draw HMC through the second space C (new section). To prove that LM is in the general case an approximation, we will compute its true value. Draw HON, OM, and MN. We then have $OMN = LOM =$ angle θ, which is the angle to be computed. $MN = OM \times \cos\ \theta$. $ON = OM \times \sin\ \theta$.

$$LP = 2\,\frac{LS}{n} = 2\,\frac{d}{n}. \quad OP = \frac{d}{2} - 2\,\frac{d}{n} = \frac{d}{2}\left(1 - \frac{4}{n}\right)$$

$$HO = \frac{d}{2}\sqrt{3}.$$

From the similar triangles MNH and POH we get the proportion:

$$\frac{MN}{PO} = \frac{ON + HO}{HO}$$

and when the values are substituted this becomes the quadratic equation

$$\sin^2\theta\left[3 + \left(1 - \frac{4}{n}\right)^2\right] + 2\sin\theta\left(1 - \frac{4}{n}\right)^2\sqrt{3} = 3 - 3\left(1 - \frac{4}{n}\right)^2$$

giving the desired angle.

$$\sin\theta = \frac{\sqrt{9 - 6\left(1 - \frac{4}{n}\right)^4} - \left(1 - \frac{4}{n}\right)^2\sqrt{3}}{3 + \left(1 - \frac{4}{n}\right)^2}$$

Testing this equation for various values of n, we get,

for $n = 2$ $\sin\theta = 0$ $\theta = 180$ degrees. Exact
for $n = 3$ $\sin\theta = \frac{1}{2}\sqrt{3}$ $\theta = 120$ degrees. Exact
for $n = 4$ $\sin\theta = 1$ $\theta = 90$ degrees. Exact
for $n = 5$ $\theta = 71$ degrees, 57 minutes, 20 seconds.

This is 2 minutes 40 seconds too small, for $\frac{360}{5} = 72$ degrees.

The error is $\frac{1}{8100}$th of the whole circle and is negligible for graphical purposes.

for $n = 6$ $\sin\theta = \frac{1}{2}\sqrt{3}$ $\theta = 60$ degrees. Exact
for $n = 7$ $\theta = 51$ degrees, 31 minutes, 5 seconds. Not exact, because $\frac{360}{7} = 51$ degrees 25 minutes, 43 seconds.

for $n = 360$ $\sin\theta = 1$ degree, 5 minutes, 48 seconds, but $\frac{360}{360} = 1$ degree.

GEORGE B. GRANT

Philadelphia, Pa.

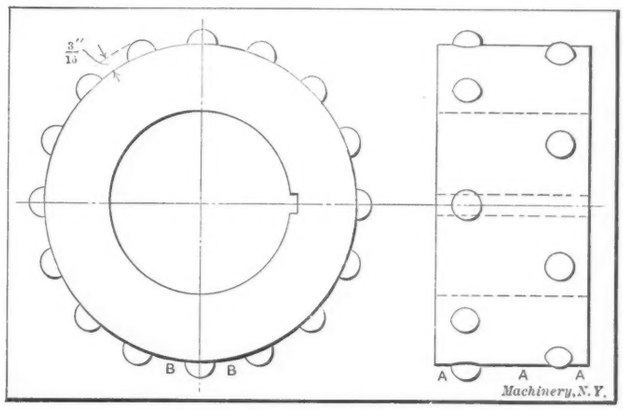
[Methods for dividing a circle into any number of equal parts have also been received from Prof. W. L. Benitz, University of Notre Dame, Notre Dame, Ind.; W. A. Knight, Columbus, Ohio, and Harry K. Reinoehl, Massillon, Ohio.—EDITOR.]

MAKING EMBOSSING ROLLERS

In reading the article entitled "The Detail Engineer" in the May number of MACHINERY, I was much impressed by the answer of Mr. Steelworth when he replied to the "old man" that he did not believe in "modern practice." In these days when special machines and advanced methods are available for doing different classes of work, the same methods are not followed that were a decade or so ago, and figuratively speaking, what is standard practice to-day, is an obsolete method to-morrow. Now I will ask, "What is modern practice? Can we follow it and how far?" To give an illustration of this, I had charge of a shop a few years ago and an order came in for a pair of rollers which were to be used for embossing straps for boxes. I had previously instructed one of the toolmakers to carry out my orders in making these rollers, but when he saw that my method was contrary to "modern practice," he sought to enlighten me and said that it would be impractical to make the rollers in this way. He claimed that to make these rollers accurate, a universal milling machine was required, and it would also require an expert diesinker. I came to the conclusion that the job was beyond his skill and relieved him of it. I may mention that this man was also a graduate of the "modern practice" school. After determining the size of the rollers, I bored, turned and keyseated them. After this I coppered the faces of the roller, and laid them out for an equal number of projections. Then, with a parting tool, I removed the superfluous stock at A, leaving ridges around the periphery of the roller. The superfluous stock at B was removed by putting the roller on an arbor and then placing this on the centers in a shaper, and planing out the remaining material. This left a series of small squares around the periphery of the roller. The roller was now put in the vise and each projection carefully filed around to the line which was made with the dividers. After rounding all the projections to the marks, I filed them as spherically as possible. Then I made a female punch of the exact shape required and used this for forming the projections into a spherical shape. The roller was then hardened in the usual manner. The female roller was laid out for an equal number of indentations to correspond to the male roller and the holes drilled with an ordinary twist drill and reamed to the size required, which would be equal to diameter of the projections on the male roller, plus twice the thickness of the material. This roller was also hardened in the usual manner. Some will probably say that this is not "modern practice," and perhaps it is not, but as one toolmaker could not make the rollers with any kind of practice, and as by using this method the rolls were made in an accurate manner, which was satisfactory to the customer, I would like to know what others have to say about "modern practice." I believe a better term for this would be "common sense practice."

L. ROSENTHAL

Passaic, N. J.



Male Roll for Embossing Box Strap

CALCULATING THE WEIGHTS OF STEEL PLATES

For obtaining the weights of steel plates, the accompanying table may be used to advantage. First, multiply the length of the plate by its breadth, and then the product by the constant given in the table opposite the thickness of the plate.

Thickness	Constant	Thickness	Constant
$\frac{3}{16}$	0.0526	$\frac{9}{16}$	0.158
$\frac{1}{4}$	0.07	$\frac{5}{8}$	0.1748
$\frac{5}{16}$	0.0874	$\frac{3}{4}$	0 2096
$\frac{3}{8}$	0.1048	$\frac{7}{8}$	0.2452
$\frac{7}{16}$	0.1226	1	0.28
$\frac{1}{2}$	0.14	..	.....

Cincinnati, Ohio.

FRANK W. HOLCOMB.

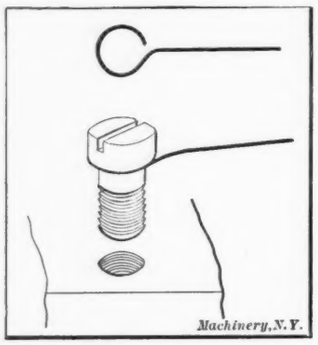
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

INSERTING SMALL SCREWS

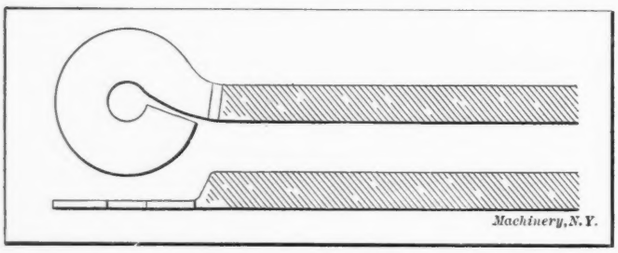
The illustration shows a method of holding very small screws ready for insertion in their holes, when one finds it clumsy and difficult to hold them with the fingers and manipulate the screw-driver. Take a piece of fine wire and bend the end into a loop equal in diameter to the body of the screw. When the latter is dropped into the ring thus formed, it will be supported steadily so that it can readily be inserted into the hole. After two or three turns with the screw-driver, remove the wire by simply pulling it, which will straighten it and free the screw.



Bath, Eng. FRED HORNER

SCRAPER MADE FROM SQUARE FILE

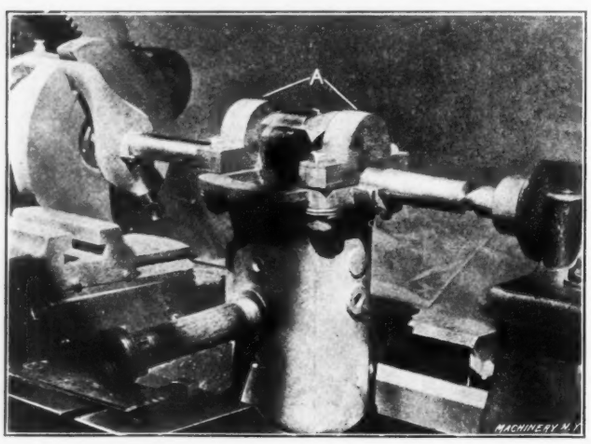
For several years I have used a scraper, made from a square file, that has been very serviceable for scraping babbitt boxes in getting clearance for the shafts. I find that I can rough scrape a box quicker with one of these scrapers than with any other I have used, finishing up with a smoothing scraper. The scraper illustrated was made from a ⅜-inch square file. The scraping end is 1½ inch in diameter and ⅛ inch thick. The size of the end will depend, of course, on the size of file used.



J. T. CROMACK

METHOD OF LAPPING PISTON RINGS IN A LATHE

The accompanying illustration shows a simple and effective method of lapping piston rings and cylinders of small gas engines. The piston rings are pinned in place, and the crankshaft assembled. The piston is then inserted in the cylinder and the crankshaft placed on the centers of the lathe, wooden blocks *A* being used instead of regular caps to hold the crankshaft in place. A mixture of pulverized glass and lard oil used as an abrasive gives very satisfactory results.



Cleveland, Ohio. JOHN W. WICKERMAN

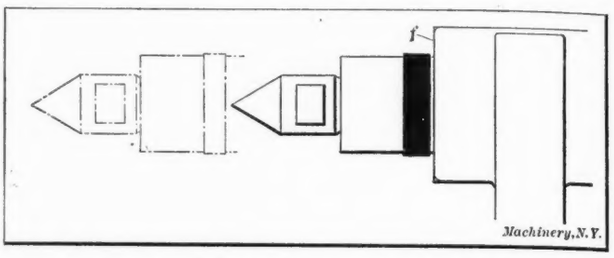
USING BROKEN TAP SHANKS FOR HACKSAW PINS

The shanks of No. 6 taps make excellent pins on which to stretch hacksaws either in hand or power frames. Ordinary soft pins are generally used for this purpose, and it is well known that they will only stand up for a few weeks when in constant use. Tap shanks are to size, and tempered just right, and they out-wear soft pins many times.

Middletown, N. Y. DONALD A. HAMPSON

DEPTH GAGE FOR TAILSTOCK DRILLING

When the tailstock of a small lathe is used for feeding up drills, there is no way of gaging the depth to which the drill has penetrated, unless the spindle happens to be graduated, which is far from usual. A kink which may not be known generally is to use a stout rubber band on the spindle as a gage. When the drill begins to cut, this band should be against the face *f*; it is then easy to determine the amount of feed by measuring the distance that the band stands away from this face, as indicated in the drawing by the dotted outline.

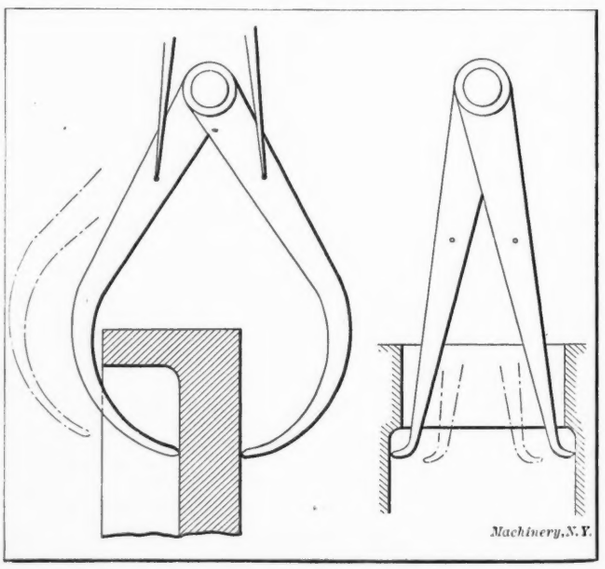


FRED HORNER

Bath, Eng.

CALIPERING OVER FLANGES

When it is necessary to gage the thickness of a piece of work which lies behind a flange, the ordinary calipers are of no use, because the dimension is lost as soon as the calipers are opened for removal. The view to the left shows a neat method of enabling the setting to be repeated. All that need be done is to make a fine prick-punch mark on the face of each leg, and carefully measure the distance these are apart with the points of a pair of dividers. After the calipers are removed by opening them until they will clear the projecting flange, they should be closed in again until the punch marks again coincide with the divider setting, when the distance between the caliper points will equal the thickness of the work. If this is done with care, very accurate results may be obtained. The same method is applicable to inside calipers when taking the size of chambered recesses, etc. The caliper setting is changed (as shown by the dotted lines in the right-hand view) to get them out of the narrowed hole, and then they are again opened until the punch marks are the correct distance apart.

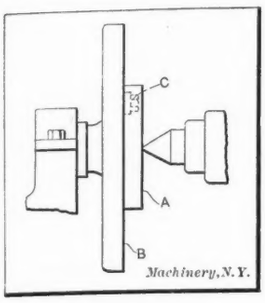


FRED HORNER

Bath, Eng.

FACING A DIE BLANK IN THE LATHE

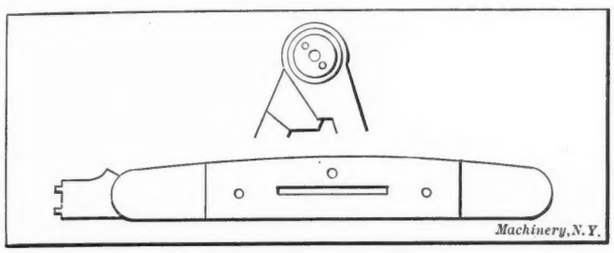
In a small shop where a shaper was not available, the following method was used for facing the die blank: The die blank *A* was centered and placed on the faceplate *B* of the lathe. The tailstock center was then located in the center and a bolt *C* clamped in position against one edge, acting as a driver. While this method is not up-to-date, it appeared to me as being ingenious.



L. ROSENTHAL
Passaic, N. J.

COMPASS KEY

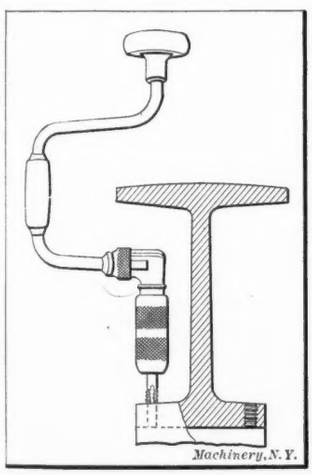
The sketch shows the novel use made of a broken knife blade, by filing the end of the broken blade to the shape shown, and using it as a compass key. In sets of instruments containing compasses with the style of joint shown, a separate key is usually provided, but the latter is small and inconvenient to use, and is often lost from the set in a little while. I keep the other blade of this knife sharpened to a razor edge for erasing.



DESIGNER

USING A CARPENTER'S BRACE FOR TAPPING

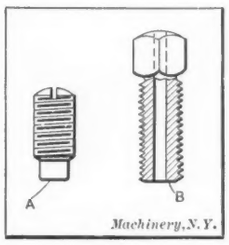
A convenient method of tapping a hole in a position where an ordinary tapping wrench could not be used on account of the location of the hole, is shown in the accompanying illustration, the hole being in the hub of a pulley in front of a spoke. A monkey wrench could have been used for the purpose, but would have been awkward. As it was, the mechanic used an ordinary carpenter's ratchet brace for holding the tap. With the right-hand ratchet he tapped the hole, and with the left-hand ratchet withdrew the tap. This method was, of course, much more rapid than using a wrench, and also enabled the mechanic to push on the tap while tapping and pull on it while withdrawing.



H. PRIME KIEFFER.
New York City.

METHOD OF SPOTTING FOR PILOT SET-SCREWS

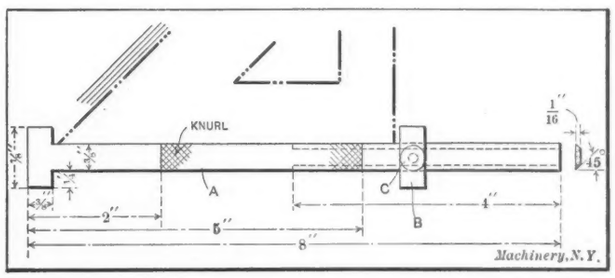
We had some cast-iron gears to be located on a machine spindle and held in place by a pilot set-screw shown at *A*. The spindle was made from tough steel, and it was necessary to drill the hole for the pilot screw with a motor drill. We tried to spot the spindle with a tapping size drill, the result being that by the time the hole was deep enough in the spindle, the drill had cut away part of the threads in the gear. We also tried spotting the spindle with a center punch which was made the size of the tapping drill, but this also gave poor results. The screw shown at *B* was then made with a ⅛-inch hole drilled through the center and hardened. This screw was then screwed into the tapped hole in the gear and used as a jig. After drilling the ⅛ inch hole, the screw *B* was removed and the hole enlarged with the tapping size drill, without removing any of the thread. After the screw was made it was found to be useful for other jobs where pilot set-screws were used for holding handles, facing cutters, gears, etc. It was useful, not only as a jig, but also as a clamp for holding the parts in position while spotting.



A. NIELSEN
Cleveland, Ohio.

HOME-MADE SECTION LINER

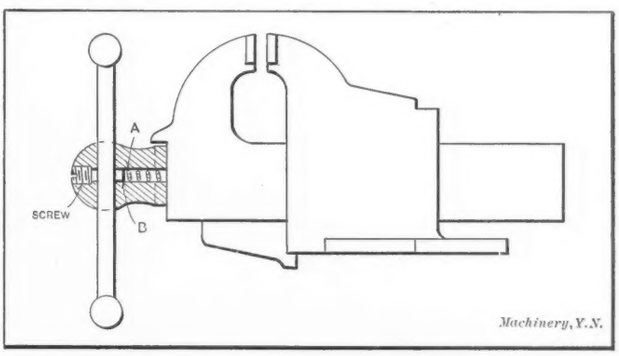
I recently visited a shop where several of the draftsmen were supplied with the home-made section liner shown in the accompanying engraving. This instrument is easily and cheaply made, as it consists of only three pieces. All the parts are made of cold-rolled steel, and are casehardened. The casehardening is not essential but will add to the life of the instrument. The bar *A* is shaped to fit the sliding block *B*, which is clamped in position by the small screw *C*. In operation, the instrument and the triangle are alternately moved along the edge of the T-square, the spacing having been adjusted by clamping the block *B* in the desired position. The end of the bar *A* should be burred slightly, to prevent the block from sliding off. A projecting pin instead of the knurling on the bar, may be preferred by some as a means of moving it along.



DESIGNER

HAND PROTECTOR FOR VISE HANDLES

In the March issue of MACHINERY, Mr. A. G. Johnson shows a device for protecting the hand from a falling vise handle. His device consisted of a piece of rubber which is placed under each ball. The accompanying illustration shows another device which is used for this purpose. A spring *A* inserted in the head of the vise screw presses against plunger *B*, preventing the handle from falling.



A. NIELSEN
Cleveland, Ohio.

CLAMPING STRAP FOR JIGS

For holding one or more pieces in a vise or jig where an even pressure throughout the entire length is sought, the concave strap has proved effective. A word of explanation will suffice for those unfamiliar with it. The strap is bent so as to have a uniform curve throughout, and is placed with the

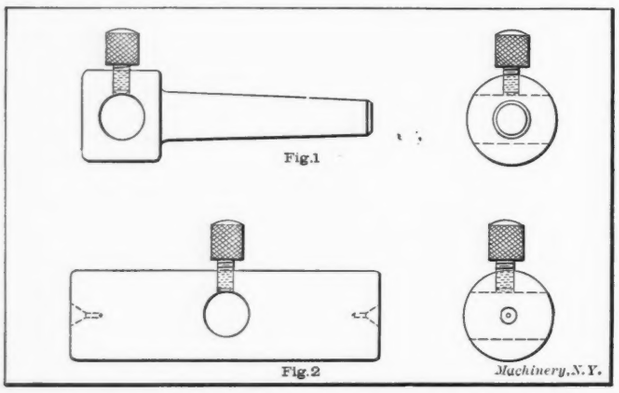
convex side next to the work. Then when the bolts on the ends are tightened, holding the strap down its entire length, the parts in the center of the jig are held as securely as the ones at the end, which is not the case when a straight strap is used. Planing one side of a cold-rolled sheet-steel strap will give it about the proper curve. For example, a piece ¾ by 1¼ by 8 inches long planed down to ¾ by 1 inch will spring about ⅛ inch, which is usually a good average deflection.

DONALD A. HAMPSON

Middletown, N. Y.

DIAMOND TOOL HOLDER FOR THE BENCH LATHE

A diamond tool holder for use in a bench lathe is shown in Fig. 1. This holder is attached to the tailstock and is very convenient for the reason that it enables the operator to dress the wheel without moving the slide rest when the latter is set to a position. The surface of the emery wheel is dressed flat



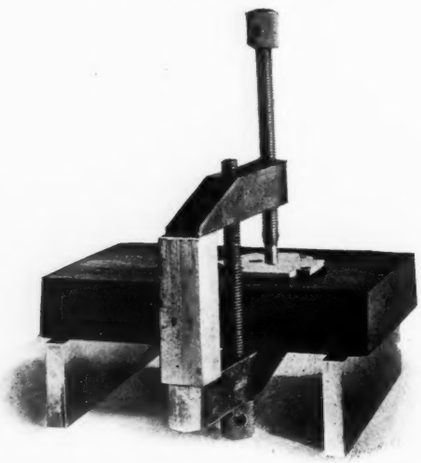
and parallel by turning the handle of the tailstock back and forth. Another very handy diamond tool holder is shown in Fig. 2. This holder is held between the centers of the lathe, and the diamond tool is held stationary by placing its handle on a rest. The emery wheel is trued by moving the slide rest to and fro. The diamond tools are held in each of these holders by tightening the knurled screws shown.

A. L. MONRAD

East Hartford, Conn.

CLAMPING TEMPLET TO DIE BLANK

Having recently seen in MACHINERY and other mechanical papers clamps made especially for holding templets on the face of die blanks while scribing the outline, the accompanying engraving is submitted showing the manner in which the ordinary tool-maker's clamp may be used for this purpose. The engraving is self-explanatory: One of the jaws of the clamp is reversed and a piece of wood or metal is used for



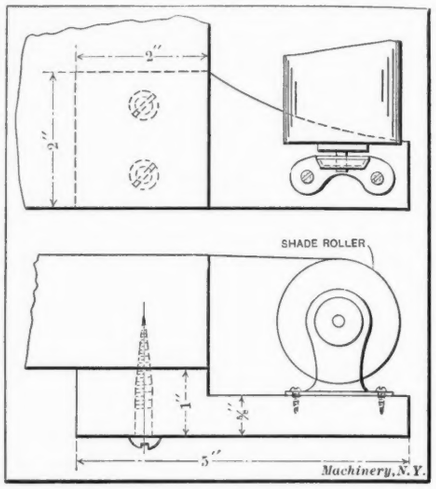
blocking up the outer end. The chief advantage of this little "kink" is that it does not necessitate the expense or trouble of adding an extra tool to the kit, as the clamp shown is a tool that every diemaker has.

ROY PLAISTED

New York City.

COVER FOR DRAWING-BOARDS

The device illustrated herewith is a simple and inexpensive arrangement for protecting drawing-boards from dust and dirt. Black oilcloth mounted on an ordinary shade roller and



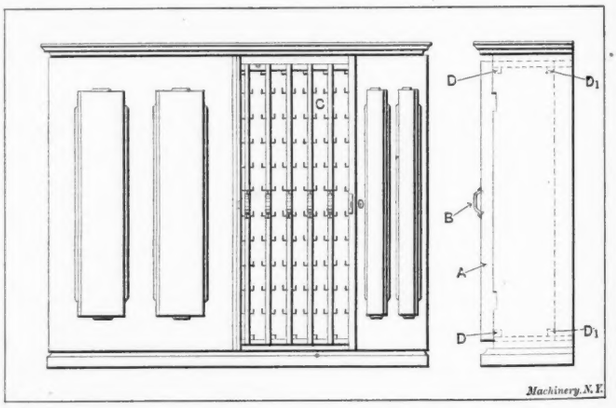
hangers on the back of the board, are used as shown. The blocks for supporting the fixtures should be arranged so as to bring the top of the roller slightly below the level of the back of the board, to keep dust from entering at the back. The roller should also project far enough from the back edge to clear whatever kind of parallel attachments are used in connection with the board.

The cover can be drawn down and rolled up like an ordinary window shade, and makes a very efficient and satisfactory covering.

DESIGNER

TOOL-ROOM CASE FOR GEAR CUTTERS

A simple form of case or cabinet for gear cutters is illustrated herewith. It is specially constructed in its interior so that each cutter may be kept in an individual place. The interior is divided into compartments by slides *A*, which have rows of hooks *C* on each side, upon which the cutters are hung. Each slide is provided with a handle *B* so that it may easily be withdrawn from the case when a cutter is to be re-



moved. Blocks D_1, attached to the rear of each slide, make it impossible to pull the slides entirely out, as they strike against the blocks *D* attached to the case. The number of hooks should, of course, be determined by the size of the cutters. The advantages of using a case of this kind are as follows: The cutters can always be easily found when wanted; they are kept in good condition; the case is good for the tool check system; and last, but not least, the cutters are in an orderly condition.

L. H. GEORGER

Buffalo, N. Y.

* * *

It is stated in the *Brass World* that plaster of Paris will harden rapidly if 0.25 per cent of sodium bisulphate is added to it. The sodium bisulphate should be dissolved in the water used for making the plaster. The strength of the hardened mass is also stated to be increased nearly three times.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

SOLUTION FOR CLEARING BLUEPRINTS

Dissolve enough bichromate of potash in water to color the water a deep orange—or about one tablespoonful to eight gallons of water. Wash the blueprints in clear water before and after using the solution. E. RAY CROFT.

Chambersburg, Pa.

REMOVING RUST FROM STEEL

A good method for removing rust from steel is to first rub the object with sweet oil, and then after a day or two, rub it with finely powdered unslacked lime until the rust disappears. Then give it again a coating of oil with a woolen cloth, and put it in a dry place. E. W. NORTON.

ANNEALING STEEL HAVING HARD AND SOFT SPOTS

To anneal steel having hard and soft spots, remove the scale, and heat slowly and evenly to a little above a dark red. Immerse in fresh water until almost cool. Heat immediately to a dark red and anneal in the usual way.

C. F. EMERSON.

PORTLAND-TAR CEMENT

A valuable cement used in marine practice and other places where elasticity is desirable, is made by mixing Portland cement in gas tar until the consistency is that of stiff putty. It must be applied immediately as it hardens quickly. It is not affected by water and never becomes brittle, a fact that makes it very valuable around the tailshafts of steamers or wherever there is much vibration. A. L. GRAFFAM.

Fairfield, Me.

CLEANING FLUID FOR FINE FABRICS

This cleaning fluid may not be of much use in the shop, but if some machinist should get the machine shop grime on his "Sunday-go-to-meeting" trousers, he will find it useful for cleaning out the spots; it works like magic: Sulphuric ether, three drams; alcohol, six drams; chloroform, three drams; gasoline, one quart. The mixture can be used safely for cleaning the most delicate fabrics, but being highly inflammable, it must be used with caution around fires and open lights. M. E. CANEK.

REMOVING THE COLOR DUE TO THE HARDENING

If a punch, reamer or other tool is to be hardened, and the color resulting from that process is undesirable, it may be removed by the following simple method: After the part is hardened, dip it into a glass filled with muriatic acid and allow it to remain for five seconds; then plunge it into a pail of water. In this way the polish of the steel will return and the temper will not be affected. This method is much quicker than obtaining a polish by the use of emery cloth.

Buffalo, N. Y. JOHN C. MONRAD.

ELECTRICIANS' METHOD OF SOLDERING

A method of soldering that I noticed electricians using in soldering wire is as follows: The solder is melted in a pot and then poured over the joints to be soldered, by means of a small dip ladle. Then acid, paste or stick flux is applied, and the solder again applied. This makes a good joint. The solder which drops from the joint is caught by a second ladle, or in the solder pot. In some cases, when possible, the piece is dipped into the pot, the flux applied and the work again dipped. It is important in both cases to give the piece a sharp tap after the second application, to knock off any surplus solder. HERMAN JONSON

New York City.

MOTTLED CASEHARDENED ARTICLES

There are several ways of obtaining the beautiful mottled effect on casehardened articles, but one of the simplest and most effective methods is in use in the factory of the Thos. B. Jeffery Co., Kenosha, Wisconsin. Here the usual cooling tank and screen for catching the work are in use, but in addition, an air pipe is run into the bottom of the tank in such a way that when the air is turned on the water is filled with air bubbles and is violently agitated. The result of these air bubbles striking the cyanide-coated articles during the cooling process, is some of the prettiest mottled work imaginable. E. V.

RECEIPT FOR MAKING WAX TAPERS FOR CORES

Take equal parts of beeswax and powdered rosin. Melt the wax, sprinkle in the powdered rosin, and stir until well mixed. If beeswax cannot be obtained, use paraffine. This composition does not soften the core as does the ordinary paraffine taper, because the rosin goes into the core when it is baked and hardens it. If paraffine is used, it is better to make the tapers by dipping cotton wicking into the melted composition, as the paraffine makes it rather brittle. When beeswax is used, the wicking is not necessary, and the tapers can be formed in the same manner as that employed by pattern-makers in forming beeswax fillets.

Aurora, Ill. JOHN B. SPERRY.

CEMENT NOT AFFECTED BY ALCOHOL

Gold size is valuable as a cement for setting together parts of vessels containing alcohol, for it is not affected by alcohol as are some other good cements. It has been used for setting the glass covers of circular levels, the glass afterwards being burred over in the brass shell so that it is securely held mechanically. Ordinary painters' size is used, which may be prepared as follows: Boil raw oil in a pan until it smokes; then set it on fire and let it burn for a few moments. Cover the pan to extinguish the blaze and pour while warm into a receptacle containing red lead and litharge in the proportion of one ounce of each to a quart of oil. Keep at a temperature of 70 degrees for ten days and agitate once a day.

M. E. CANEK.

TO MIX LAMPBLACK AND SHELLAC

Mixing lampblack and shellac is not so simple a matter as it appears, as many an amateur and novice has found out. The tendency is to form lumps when the two are mixed, by throwing or even sifting the former into the latter. The lumps of course can be reduced and an intimate mixture obtained by considerable patience with a paddle or pestle. The whole difficulty is easily avoided if the lampblack is first wet with alcohol and thoroughly worked down into a soft paste with a paddle or spatula. The black paste is then added to the shellac and mixed uniformly by stirring. The result is a smooth flowing and working shellac. Other pigments can be treated in the same way. O. M. B.

ANTIQUE BRASS FINISH SHOP RECEIPT

It is comparatively easy to get a nice antique finish on copper or copper-plated articles, but the treatment of brass is more difficult. Most of the processes used do not give a nice, clear black, but instead, a dull or grayish black coating. When visiting the shop of the Puritan Mfg. Co., Decatur, Ill., I noticed the beautiful jet black of the brass articles made up with the antique finish, and upon expressing my curiosity as to how it was obtained, was offered the formula. The articles are first dipped into a strong, hot solution of potash, and then well rinsed in water; they are then immersed in a mixture of one part sulphuric and two parts nitric acid, and instantly rinsed in clear, cold water. Next they are placed in a bath consisting of two ounces acetate of lead and one ounce hyposulphite of soda to each gallon of water in the tank. This solution must be almost boiling when used. The brass is moved around in this until the desired black is obtained, then rinsed and dried. When dry and cool spot on a rag wheel. If the brass doesn't turn black enough in the above solution, add the least bit more lead.

Cincinnati, Ohio. ETHAN VIALL

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

HOW TO MAKE GEAR CUTTERS FOR JOBBING SHOPS

R. G. D.—I would like some information on how to produce a moderately accurate tooth profile, so as to be able to make gear cutters for spur and bevel gears. Being located in New Zealand where the volume of gear repair work is not great, I am unable to afford a full set of cutters which would enable me to replace any broken gear. We often have to make cutters to suit the case in hand. The usual job is to cut a gear to take the place of a broken sample. We generally manage to find some portion of the broken gear so little worn that we can make a cutter to fit. We have cut several bevel gears on these lines, but the shape of the cutter has always been a troublesome matter to obtain. When we run short of cutter blanks we have to cut up a sledge-hammer, being so far away from the world's markets, and, as we seldom have to cut more than a couple of gears with the same cutter, it does not pay to expend a great deal on special cutters. By carefully hardening the cutters made from a sledge-hammer they last all right. Any information that will help us out will be appreciated.

A.—The case is submitted to the readers for suggestions.

USE OF SUB-PRESS DIES ON THICK STOCK

D. V. Co.—We would like to know if a sub-press die can be used successfully on cold-rolled steel stock of thicknesses up to 7/32 inch?

Answered by Frank E. Shallor, Detroit, Mich.

A.—I have seen and made sub-press dies for punching stock heavier than 7/32 inch. One feature that aids greatly in stripping heavy stock is making the punches a loose fit in the dies. To obtain the proper clearance for the punch in the die for all thicknesses of stock, six per cent of the stock thickness is allowed for difference of the punch and die diameters. Therefore, on 7/32 inch stock the punch would be 0.012 inch smaller than the die. When the punch pierces the stock, the diameter of the hole is the mean between the diameter of the punch and the diameter of the die. It will be seen from this that the stripping pressure required actually decreases as the stock increases. The hole punched in the stock is cone-shaped, the top diameter being that of the punch and the bottom diameter that of the die. On account of this defect it is not considered of much benefit to use sub-press construction on heavy work except to aid in setting up in the press. If the punch were made to fit the die on this thickness of stock, the conditions would have to be exactly right; that is, the stock would have to be absolutely flat, and the stripper absolutely parallel with the face of the die in order to prevent cramping on the punches and breaking them.

POWER REQUIRED FOR BENDING SHEET STEEL AND IRON

W. J. D.—Is there any formula for the force required to bend sheet steel to a right angle? Assume for example, that the sheet is one-half inch thick and 60 inches wide, and that the force is applied 13½ inches from the fulcrum or center of the bend. What would be the difference between the force required for bending sheet steel and sheet iron?

A.—Referring to the accompanying engraving, if we assume that the sheet to be bent is rigidly held on each side of the place where the bend is required, the force required for bending would be the force necessary to produce a bending moment which would produce a stress in the sheet steel which would somewhat exceed the elastic limit.

If P = force required for bending, in pounds,
t = thickness of sheet to be bent, in inches,
b = width of sheet to be bent, in inches,
l = distance between the application of the power and the center of the bend, in inches,
S = stress slightly in excess of the elastic limit of the material, in pounds per square inch,

then:

$$P = \frac{Sbt^2}{6l}$$

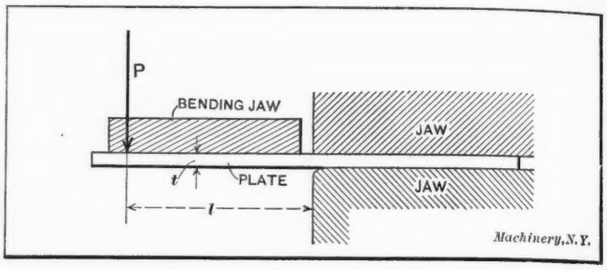
For steel plate we may assume S = 35,000 pounds per square inch and for iron plate, 28,000 pounds per square inch. Inserting the given values in the formula we find for sheet steel:

$$P = \frac{35{,}000 \times 60 \times (\frac{1}{2})^2}{6 \times 13\frac{1}{2}} = 6480 \text{ pounds.}$$

and for sheet iron:

$$P = \frac{28{,}000 \times 60 \times (\frac{1}{2})^2}{6 \times 13\frac{1}{2}} = 5185 \text{ pounds.}$$

The values of S will vary considerably for various grades of steel and iron, and also with the condition of the steel. If



unannealed the value will be higher than if annealed. This uncertainty makes calculations of this kind only approximately correct, and ample latitude must be given in designing machinery for bending to provide sufficient power for all conditions.

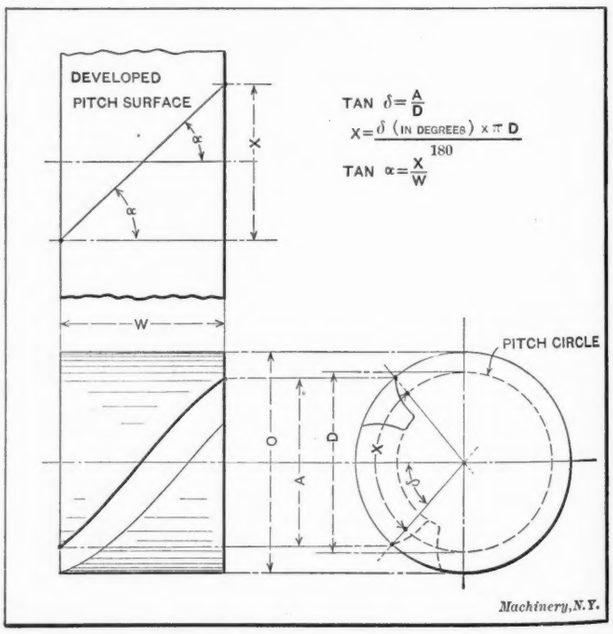
CALCULATING ANGLE OF HELICAL GEAR FROM SAMPLE

O. F. W.—There is one point I do not find explained in books on spiral gearing that I am anxious to find out about. How can you figure out the helix angle or tooth angle, when you have to make a new gear like a sample, as is often the case in jobbing and repair work, etc.? It is assumed that no drawing is furnished.

A.—To calculate the helix angle of a helical gear already cut, we will have to know the following dimensions. See the accompanying diagram:

W = width of face,
A = advance of tooth in width of face,
O = outside diameter,
D = pitch diameter.

All of these measurements are taken directly from the sample,



except that for the pitch diameter. This is obtained from the normal diametral pitch, or pitch of the cutter used, as follows:

$$D = O - \frac{2}{Pn}$$

We have first to calculate the distance on the pitch diameter which the tooth advances on the helix in the width of face. This is marked X on the diagram, and is measured on the cir-

cle as shown. To find this, we first find angle δ by the following calculation:

$$\text{Tangent } \delta = \frac{A}{2} \div \frac{D}{2} = \frac{A}{D}$$

X can evidently be found by proportion, as follows:

$$\frac{X}{2} : \pi D :: \delta : 360 \text{ deg.}$$

in which, of course, πD is the pitch circumference or $3.1416D$. This proportion may be simplified to the following expression:

$$X = \frac{\delta \pi D}{180}$$

In this, of course, δ stands for the number of degrees in the angle. If the calculation brings this to an odd number of degrees and minutes, the minutes should be reduced to decimal degrees; thus, 15° 45′ would become 15.75°.

Having thus found the advance on the pitch circle that the helix makes on the width of face of the gear, we can easily get the helical angle as shown in the development of the diagram. This development is, of course, a section of the surface of the pitch cylinder laid out flat on a drawing-board.

$$\text{Tangent } \alpha = \frac{X}{W}$$

The process we have given here is the exact one applicable to gears of any helix angle. For cases where the angle is comparatively slight, as in your case, it might be safe enough to find X approximately from A by the proportion:

$$X : A :: D : O \text{ or } X = \frac{AD}{O}.$$

This, of course, is not quite correct, as X is measured on the straight line.

* * *

DON'TS FOR THE PREVENTION OF ACCIDENTS IN THE MACHINE SHOP

By H. P. WENTWORTH*

Don't wear loose fitting garments.

Don't forget to roll up your sleeves.

Don't wear jewelry on your hands while in the shop.

Don't oil or clean a machine while it is in motion.

Don't attempt to look about you while busy at a machine—attend strictly to business.

Don't neglect to replace gear guards after removing them for cleaning, repairs or other purposes.

Don't (while at work on a stamping press) forget to remove your foot from the treadle while putting in or removing work from the dies.

Don't put your fingers in the dies to remove work; use a stick or the implement furnished for that purpose.

Don't set up or take down a job in the press until you have thrown off the belt.

Don't throw off the belt with your hand—use a stick.

Don't fail to see if the spring on the treadle is in working order before you start; it should withdraw the treadle immediately, allowing the machine to trip but once.

Don't use a weak or shaky stool or bench while working at a stamping press.

Don't allow scrap or stampings to collect on the floor.

Don't drill a piece of work until you are sure it is securely held.

Don't fail to withdraw the milling machine table far enough when removing work, to prevent the hands or clothing from coming in contact with the cutter.

Don't use a file without a handle, especially in a lathe.

Don't leave a chuck wrench standing in a chuck; always remove it.

Don't touch or jostle a fellow while he is working on an emery wheel if you can prevent it.

Don't forget to use the wheel with care as it does not take a very strenuous blow to cause it to break; especially a small one.

Don't try to stop an emery wheel with your fingers.

Don't try to talk and work at the same time; you cannot do two things at once and do them well.

Don't strike matches and throw them carelessly from you; be sure they are out.

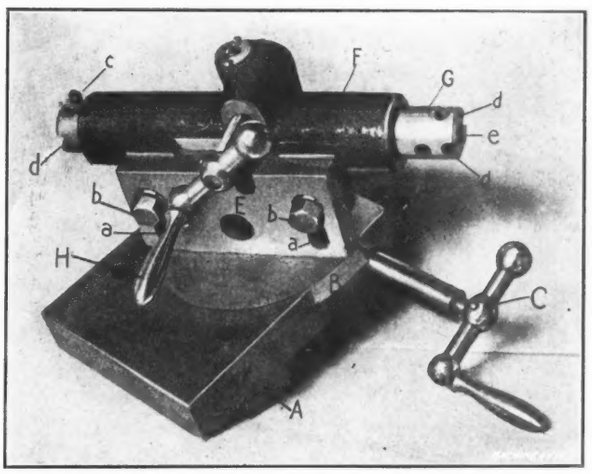
Don't fail to report if any part of your machine is out of working order. "An ounce of prevention is worth a pound of cure."

* * *

TAPER TURNING ATTACHMENT

By WILLIAM Z. BEAN*

The accompanying illustration shows an interesting attachment for taper turning, which can be used both for internal and external work. This attachment is provided with a tongue A which is located in the T-slot of the lathe, and is held by two capscrews, which are screwed into two nuts placed in the T-slot. The desired angle is obtained by rotating the handle C, thus moving the part B on which the angular graduations are laid out in either direction. When the desired angle has been obtained, the part B is securely held by wing-nut D. Slots a are provided so that the cutting tool may be adjusted vertically to accommodate any swing of lathe, the capscrews b being used for holding the movable part in the desired position. The handle H operates the spindle G shown protruding from each end of the sleeve F.



Taper Turning Attachment for Internal and External Work

In one end of the spindle G is shown a cutting tool c which is made from 5/16 Crescent steel. Small holes d are provided in each end of the spindle G for holding these tools. A small tool suitable for internal work can be inserted in hole e, which permits this fixture to bore deep holes which are smaller in diameter than the spindle G. The hole E is used for securing another attachment which is not shown, whereby balls may be turned or castings cupped out to a given radius; but to apply this attachment it is necessary to remove the sleeve F containing spindle G and its operating handle H, when the other attachment can be secured in its place. The fact that this is a portable attachment permits it to be readily applied to the milling machine by securing the tongue A in the milling machine vise, whereby collets, convex cutters, bevel gears and work of a similar character may be turned, by securing them in a suitable fixture held on the nose of the spindle.

* * *

An account of the industrial operations of the Japanese government is published in the *London and China Telegraph*, and contains some matter of interest. During the past year the government's steel works produced 20,000 tons of steel plate and 25,000 tons of rails, besides about 55,000 tons of steel bars and structural material of various kinds. According to financial reports, the net profits arising from the Japanese Government's industrial enterprises for the year ending March, 1909, amounted to nearly $31,000,000, the greater part of which accrued from the tobacco and salt monopolies.

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AEROPLANE FLIGHTS—ALBANY TO NEW YORK—NEW YORK TO PHILA. AND RETURN

Glenn H. Curtiss, the well-known aviator, made a remarkable aeroplane flight May 29, when he flew from Albany to New York, for which feat he received a prize of $10,000 from the New York *World*. Two stops were made during the flight, one for gasoline at a point near Poughkeepsie and a second at 214th St., New York City, for obtaining a supply of oil. The entire distance from the starting place at Albany to Governor's Island, where the flight ended is 150 miles, which was traversed in two hours and forty-six minutes of actual flying time, at an average speed of approximately fifty-four miles an hour. This is somewhat faster than the scheduled time of the Twentieth Century Limited, between Albany and New York, as this train covers its run of 143 miles at an average speed of 49.6 miles an hour. The machine used which was of the biplane type was driven by a 50-horsepower, eight-cylinder engine, connected with a two-blade propeller, which gave a horizonal thrust of 350 pounds. Two air-tight metal caissons and five air bags were attached to the aeroplane to keep it afloat in case it dropped into the Hudson River, which latter was followed by Mr. Curtiss in his flight. The trip as far as the Catskill Mountains was made at an altitude of about 1000 feet. When the mountains were reached, perilous air currents made it necessary to glide to higher levels and it is estimated that at one time the machine was 4000 feet above sea level. The entire flight which, including stops, required 4 hours, 57 minutes, was made without an accident, though at one time Mr. Curtiss states that he temporarily lost control of the machine because of adverse air currents which caused it to lurch over sidewise and downwards with considerable rapidity. This aero trip, while not quite as long as the one made by Mr. Paulhan in England, is in some respects a more wonderful demonstration of the possibilities of aero flight, as the territory traversed offered a greater variety of perils than those encountered on the trip from England to Manchester.

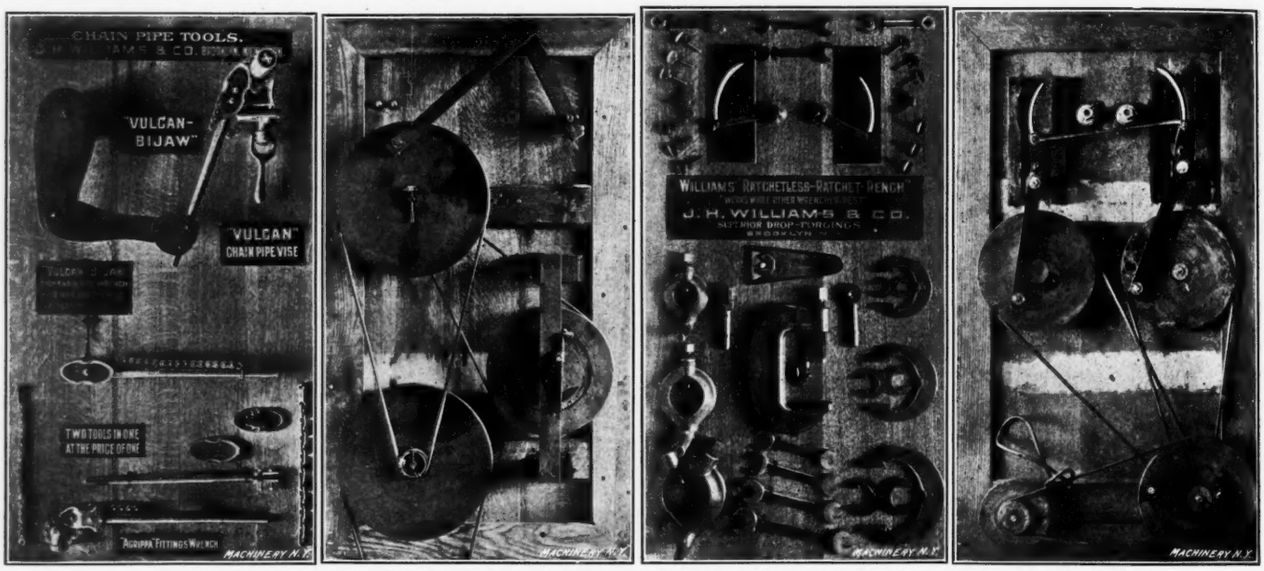
History is being made so rapidly in the progress of aviation that it is difficult for a monthly journal to keep abreast of the times. In another part of this issue is a note regarding the record of Paulhan's long-distance flight from London to Manchester. Since that portion of this issue, which went to press early in June, was printed, and the above, recording Curtiss's exploit, was written, Charles K. Hamilton made a flight from Governor's Island, New York, to Philadelphia and back the same day with a Curtiss biplane. He thereby won the prize offered by the New York *Times* and the Philadelphia *Public-Ledger* for a round-trip flight made between New York and Philadelphia in twenty-four hours. The aviator left Governor's Island at 7:36 A. M. and landed at Philadelphia at 9:26, the distance being 86 miles. He started on the return trip at 11.33 A. M. and when near South Amboy defective spark plugs forced him to descend at 12:54, the descent resulting in breaking the propeller. The propeller was repaired and the machine started again at 6:17 P. M. and reached Governor's Island at 6:40. The return distance was about 89 miles counting three miles made in the detour consequent to landing at South Amboy. Hamilton followed the line of the Pennsylvania R. R. most of the way, and a special train of three cars accompanied him going and coming.

* * *

J. H. WILLIAMS & CO.'S MOTION SAMPLE BOARDS

The accompanying illustrations, Figs. 1 to 4, inclusive, show front and back views of two classes of motion sample boards made by J. H. William & Co., Brooklyn, N. Y., for advertising their line of chain pipe tools, C-clamps, lathe dogs, standard drop-forged wrenches, Williams ratchet wrenches, snap gages, thumb-screws, etc. The motion boards were designed to illustrate the action of the Vilcan bi-jaw pipe wrench and the Williams' "ratchet" wrench, these tools being actuated by the mechanism shown in the back views. One-eighth horsepower electric motors are employed for actuating them.

The reversible feature of the ordinary chain pipe wrench with serrations at one end of the jaws only, which permits either side of the jaws to be used at will to grip the pipe is well-known, but the two-fold advantage of the double-end serrations of the Vilcan bi-jaw wrench has not yet been so generally appreciated, and the motion board was designed to show it by automatic demonstration which could be repeated *ad libitum* at small cost.



Figs. 1, 2, 3 and 4. Front and Back View of J. H. Williams & Co.'s Motion Sample Boards showing Tools and Mechanism

Many readers no doubt are unfamiliar with the "ratchet" wrench—a wrench without ratchet mechanism, but having essentially the ratchet action in use. It is a drop-forged machine wrench with one short jaw rounded so that it automatically releases the nut on the backward stroke, allowing the wrench to roll around the nut and engage the next square. The operator can use the wrench on either square or hexagon nuts without lifting and carefully adjusting it on each square as is necessary with the ordinary type. It "just naturally" falls into place on the back stroke. The motion board Fig. 3 plainly shows this action on both square and hexagon nuts.

J. H. Williams & Co. expect to show the motion boards at the leading mechanical conventions and then they will be offered to the leading machinery merchants throughout the United States for display in their stores and store windows.

* * *

According to a paper read before the Pittsburg Foundrymen's Association, large patterns made of concrete reinforced with wire have been successfully used in a foundry at Niagara Falls, N. Y. The cost of these patterns is very much less than that of ordinary wooden patterns.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month.

THOMPSON UNIVERSAL GRINDING MACHINE

A universal grinding machine that has been designed for the purpose of combining in a single machine, efficient means for the accomplishment of every possible grinding operation that may be required in the tool-room and general shop, is illustrated in Fig. 1. This machine is manufactured by the Thompson Grinder Co., of Springfield, O.

Fig. 1. Thompson Universal Grinder as arranged for Grinding Work between the Centers

The grinding wheel on this machine is maintained in a fixed position at all times, and the grinding table carrying the work to be ground, is made adjustable to any desired position relative to the wheel. The head is rigidly mounted upon a column that is solidly attached to the base, and surrounding the column is a trunk or body casting, that revolves upon a bearing on the base. This body casting carries the elevating knee, saddle casting and grinding table, which may be adjusted to a position at right angles to the spindle at either end, parallel to it, or at any intermediate position. This feature renders this machine capable of being converted in a moment's time into either a plain grinder for grinding straight or taper work between centers, a surface grinder, a knife grinder, an internal grinder, a die grinder, or a cutter grinder, each of which is perfect in its action.

Fig. 1 shows a front view of the machine as it appears when converted into a plain grinder for grinding work between centers. When so arranged, it has a capacity for either straight or taper work up to 10 inches in diameter by 36 inches long. With the table in this position, the overhead drum of the countershaft is parallel with it and, by means of a weight, the drum is automatically adjusted to the height of the grinding table, thus keeping a uniform tension on the belt.

In Fig. 2 the grinder is shown converted into a surface grinder. The spindle and grinding head overhang the table in such a manner that the full width of the table, which is 8 inches, may be passed laterally beneath the wheel. The traverse of the table is 48 inches, and therefore, work 8 by 48 inches may be surface ground. The knee has a vertical movement of 10 inches, and with a wheel 10 inches in diameter upon the spindle, a space of 5 inches will be left between the table and wheel, when the table is at its lowest level.

The internal attachment is applied to the Thompson grinder as shown in Fig. 3. The headstock and a three-jaw combination chuck are mounted on the table. The machine is in the same position as when used for cylindrical grinding. The internal attachment receives its power from a pulley mounted on the grinding spindle proper. Work 4 inches deep may be ground by this attachment.

In Fig. 4 the machine is shown set up for grinding a hob, while the illustration Fig. 5 shows it with a large faceplate mounted on the headstock spindle, thus adapting the machine for either die or surface grinding. As the engraving shows, the grinding spindle is parallel with the faceplate. Figs. 6 and 7 illustrate the arrangement of the machine for grinding end and spiral mills, respectively.

In addition to the uses mentioned in the foregoing, this grinder may be converted into a knife grinder for sharpening large paper knives. The table is swung around to a position at right angles to the spindle and a cup wheel is used. Three angle pieces bolted to the grinding table can be employed to support the knife. This simple rigging will make it possible to easily accomplish the occasional job of grinding large knives. Should the machine be used regularly for this particular work, an attachment can be furnished for holding the knife at an angle, which at the same time affords

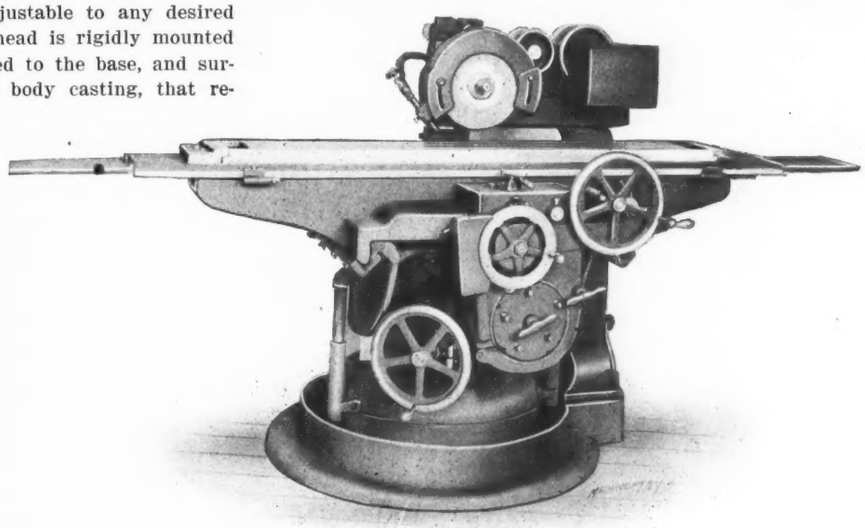


Fig. 2. Thompson Grinder Converted into a Surface Grinder

a support throughout its length.

As will be seen, this grinder, aside from being convertible into at least five distinct kinds of grinders, any of which is capable of economical production, may also be used for many other special purposes.

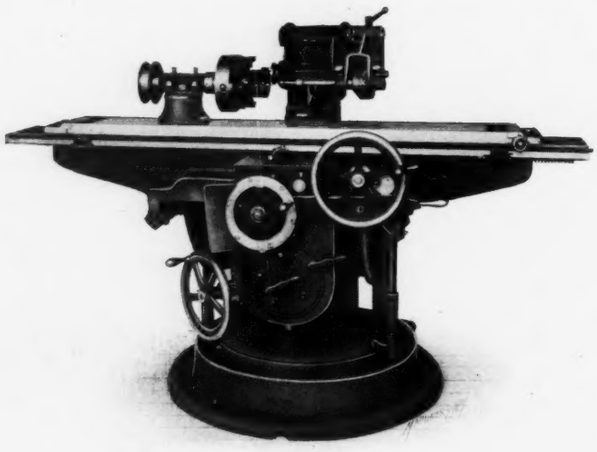


Fig. 3. Grinder Set up for Internal Grinding

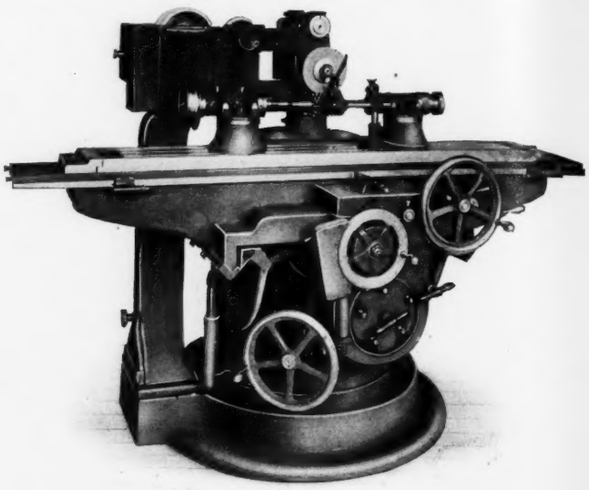


Fig. 4. Hob being ground on Thompson Grinder

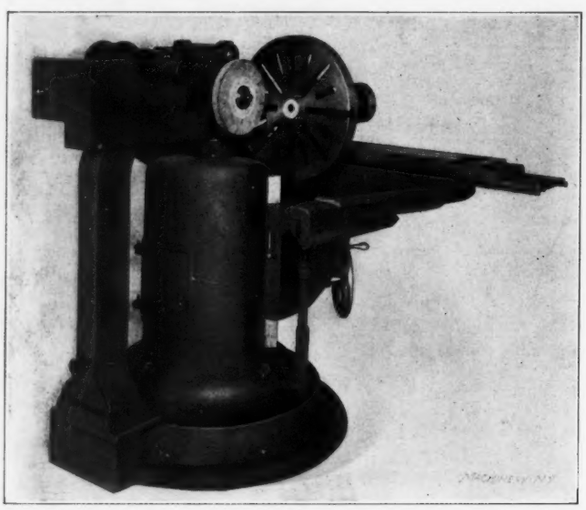


Fig. 5. Machine with Faceplate for Die and Surface Grinding

The machine has an automatic longitudinal feed to the table of 48 inches with ten independent changes, any of which is instantly obtainable. An automatic micrometer cross-feed of 8 inches is available, and the knee has a hand vertical micrometer adjustment of 10 inches. In Fig. 8 are shown some of the interior details, giving an idea of the arrangement of the gears for doubling the number of feeds in the quick-change gear box shown in Fig. 9. The pulleys marked A and A_1 act as idler pulleys, and the belt from the line-shaft makes a right-angle turn on these pulleys, passing around the pulley mounted on the spindle B. Pulley A drives, at one end of its shaft, a pair of 45-degree spiral gears C, which by means of a shaft extending to the base of the machine operates the pump for the water attachment. On the other end of the pulley shaft A, is

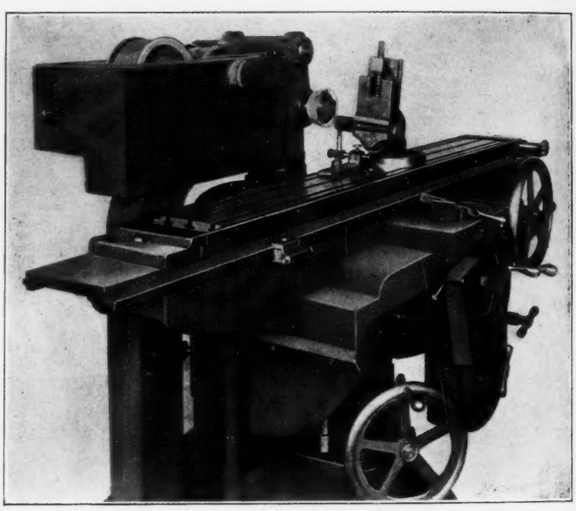


Fig. 6. Grinding an End Mill

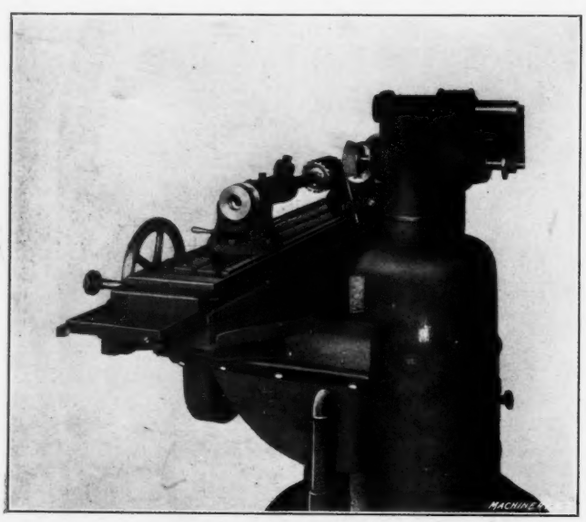


Fig. 7. Grinding a Spiral Cutter

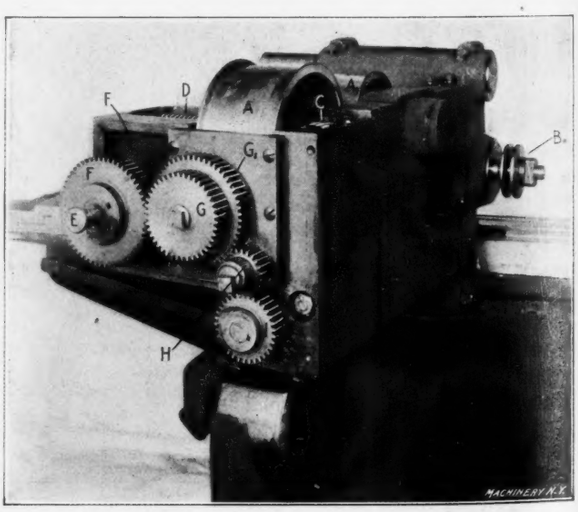


Fig. 8. Arrangement of Gears for Doubling the Number of Table Feeds

mounted the worm D meshing with a worm gear on the same shaft with the pull-pin E. Pull-pin E operates a sliding key which keys either F or F_1, to drive either G or G_1, thus giving two rates of feed. From G_1 the drive is through H and I and thence down through the body of the machine to the spur pinion J in the quick-change gear box Fig. 9. Handles K and L operate the quick-change feed mechanism, K revolving the dial, containing the five sets of change gears, and handle L being used to mesh the gears by swinging the case closed. For example, gears M and N could be made operative by turning the dial until gear M could mesh with pinion J, and gear N with O. By the engagement of slots cut in the periphery of the dial with a projecting key, the different sets of change gears are accurately located with reference to the pinion J and the gear O.

Fig. 10 gives further details of the feed mechanism, showing the way in which the reverse in the direction of the travel to the table is obtained. Gear O (Fig. 9), meshes with gear P, P

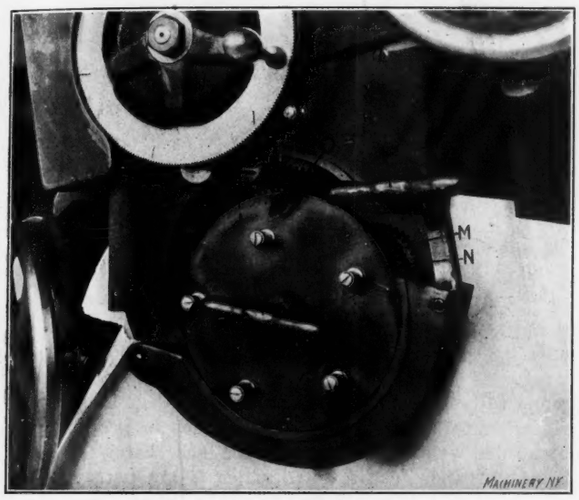


Fig. 9. Table Feed-changing Mechanism

with Q, R with S and S with Q_1. As the clutch is keyed to the shaft which operates the table travel, and gears Q and Q_1, run free on this shaft, a longitudinal table travel in both directions is obtained by means of the reversing clutch. As stated before, by this unique arrangement five changes of travel to the table are obtained by the quick-change gear box, and these

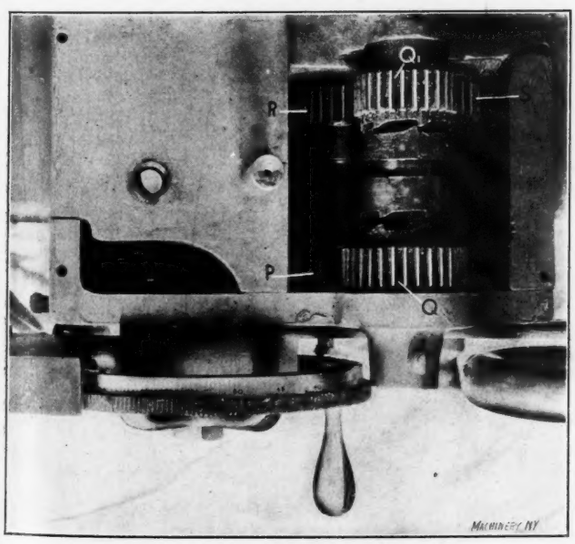


Fig. 10. Detail of Reversing Clutch Mechanism

are doubled at the back of the column by means of the pull-pin E.

Further details of the machine, especially as to the arrangement of the automatic cross feed, are shown in Fig. 11. Handwheel T operates the cross feed and handwheel U the longitudinal feed. Now when the four pawls are dropped into place in the ratchet on the handwheel T, the action of the lever V operates the cross feed. To insure engagement with the ratchet teeth of the wheel T, four pawls are used. The adjustment of the cam at W controls the amount the ratchet is advanced by the pawls, or, in other words, the

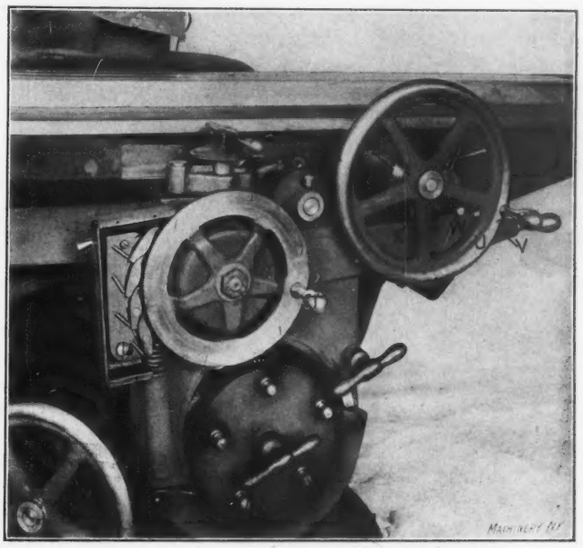


Fig. 11. Arrangement of the Automatic Cross-feed

amount of cross feed. At X is another pawl secured to the lever V. When the table travel is automatically reversed, the sprocket Z also reverses its direction, and by means of the pawl X which engages with Z, the lever V is forced down operating the cross feed automatically.

The makers have designed for this grinder a very simple countershaft as shown in Fig. 12, the drum of which ad-

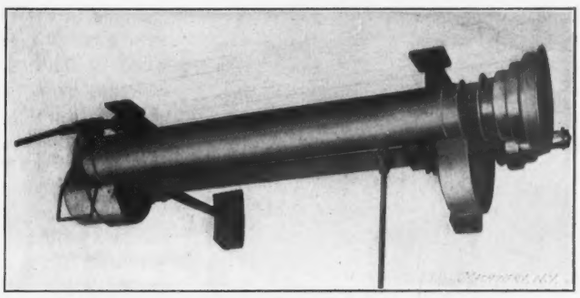


Fig. 12. Countershaft and Drum with Automatic Adjustment

justs itself automatically to the difference in the elevation of the table. It is self-contained and is very easy to hang, from the fact that the bearings are held in line by a framework, which carries the drum. This framework, which also carries the bearings for the countershaft proper, has at its outer ends ball joints which rest in sockets in the hangers.

An opportunity to see one of these machines in full operation may be had by a visit to one of the demonstration shops of Hill, Clarke & Co., Inc., of Boston, Chicago, New York, Philadelphia and Cleveland.

GEOMETRIC CHASER OR DIE GRINDER

The practice of using a set of chasers or dies until they are very dull is, of course, poor, as they will not only work much more effectively if ground at intervals frequent enough to keep them sharp, but the results produced will be of a superior quality. It is also essential that the grinding be done uniformly on all the chasers in a set, in order that the work of cutting be distributed equally, and the thread produced be regular and smooth. To enable this work to be done quickly and with accuracy, the Geometric Tool Co., New Haven, Conn., has developed the chaser or die grinder illustrated in Fig. 1. This machine is adapted for grinding any make of thread chaser, whether of a stock or special type. The die to be ground is held in a universally-mounted vise, and the ad-

justments provided are such that the die may be ground square or to any radius, and the throat can also be given any desired clearance.

Before describing the method of grinding both milled and tap-formed dies in this machine, its various adjustments will be explained. The vise in which the dies are held, as is shown more plainly in Fig. 2, is pivoted to a carriage which may be moved back and forth in front of the grinding wheel by means of the hand lever *F*. The upper handwheel *C*, operates the vise for holding the chasers in the proper position for grinding, while the small knurled wheel *D* gives the proper radius for grinding tapped dies and it is set in accordance with the scale *O*, Fig. 3. The lower handwheel *A* operates the lower cross-slide and moves the vise to and from the grinding wheel. The small knurled wheel *E* is used for adjusting the vise to the right or left of the pivot to obtain the proper clearance and also for grinding right- or left-hand chasers. It is also possible to tilt the vise by means of the leveling screws *R*, which adjustment is employed when grinding Acme or square threads of coarse pitch, and also for double and triple threads. The proper length of throat or chamfer is obtained by raising or lowering the knee on which the carriage and vise are mounted, by means of a screw operated by handwheel *G*.

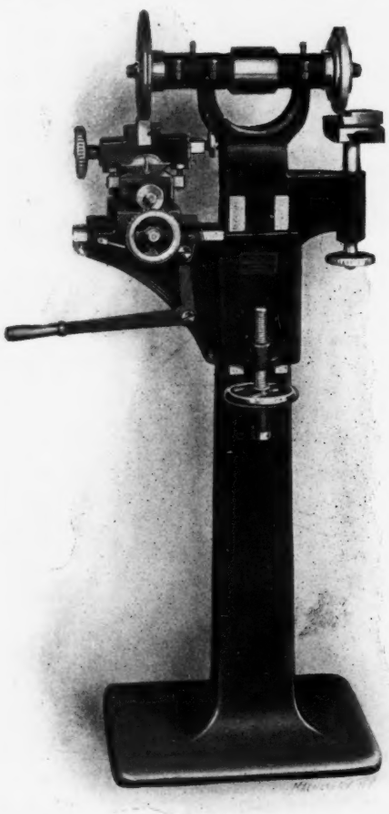


Fig. 1. Chaser or Die Grinder built by the Geometric Tool Co.

When a die is to be ground, it is clamped in the vise by means of handwheel *C*. The jaws of this vise have the same form as the clamping device of the die-head, so that the die is rigidly held in the correct position for grinding. Only one chaser is ground at a time, but as the adjustment of the vise and feed-table remain the same when once set, absolute uniformity of grinding is assured.

As milled chasers are ground mostly on the throat, the feed-table is lowered so as to bring this part of the die below the grinding wheel center. After the chaser is inserted in the chuck, it is brought up against a stop and clamped tightly. The table is then adjusted vertically by the handwheel *G* to give the proper chamfer. When a die is to be used on brass or other free-cutting metals, or if it is to be used for threading close to a shoulder, it should come in contact with the grinding wheel far enough below its center to obtain a short chamfer of, say, approximately 45 degrees. For ordinary work, the table should be set higher so that a chamfer of about 30 degrees will be obtained. When one die has been ground to the proper angle of clearance, the sleeve *B* on the lower feed-screw, which is marked with a check line, is set to indicate the amount of feed necessary. When the first die is finished and the machine is set so that remaining dies may be ground to correspond, the table is moved back for the removal of the finished die and the insertion of the second. The table is then returned to the grinding position and the die moved back and forth against the face of the grinding wheel by the hand lever *F*, while it is slowly fed forward by the wheel *A* until the check mark on sleeve *B* corresponds to a second mark on the stationary arm, with which it was previously set. When this point is reached, pins provided for the purpose form a positive stop for the feed. During this operation the swivel of the intermediate slide should be firmly clamped by handle *P*.

In addition to grinding the throat of the chaser, it is also essential that the cutting edges be touched up lightly from time to time in order to keep them clean and sharp. This is done by placing the die flat on table *K* (Fig. 2), bringing it into contact with the wheel by handwheel *J*, which controls

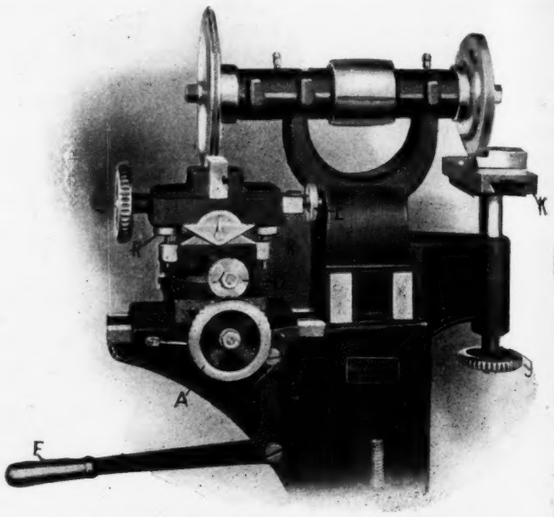


Fig. 2. Enlarged View of the Working Side of the Machine

the vertical adjustment, and moving the slide back and forth under the grinding wheel. When grinding either the face or throat of a die, all the dies of a set should, of course, be ground with the same adjustment.

In order to better illustrate the method of grinding a tap-formed die, we shall assume that a 1-inch chaser of this type is to be ground. The scale *O*, which is graduated in thirty-seconds of an inch, would first be set to the radius of the die, or to ½ inch, minus the single depth of the threads. The die is then placed in the vise against the stop and clamped. The jaws of the vise are next adjusted either to the right or left

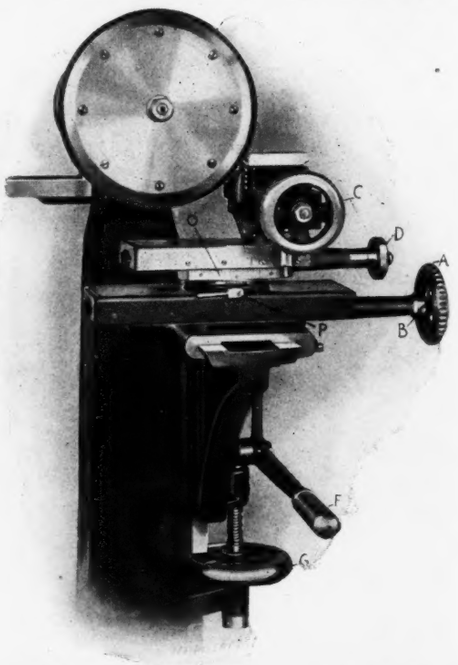


Fig. 3. End View showing Die in Position for Grinding Throat

of the center, depending on whether the thread is right- or left-hand, just enough to give the proper clearance. The swivel of the intermediate slide is then loosened and the work is oscillated about the grinding wheel, and fed in slowly by handwheel *A* until the stop is reached.

S. E. HORTON MACHINE CO.'S FACEPLATE JAWS

A new faceplate jaw has been brought out by the S. E. Horton Machine Co., Windsor Locks, Conn., that is quite different in its design from the type commonly used. This new jaw, instead of having the form of a rectangular block, is made with a broad base, which is ribbed to the body as shown in Fig. 1. This design results in a much better casting, as the metal is more uniformly distributed and, for a given weight, the support is much better, the width of the base being wider. On each side of the body, pockets are formed which serve an important purpose, in that they adapt these jaws to a wide range of work by making it possible to clamp them in positions where the ordinary jaw could not be held. As the base of the jaw is extended at each end, it may be clamped by the ends, as with the ordinary type, and the pockets provided also furnish means of clamping at the sides. Holes are drilled through the base and into the pockets on each side so that bolts can be employed when more convenient. These bolt holes also make a convenient place for dowel pins. The advantages that these various ways of clamping afford, will be apparent by referring to Figs. 2 and 3, which show the jaws mounted on a faceplate in different positions. Fig. 2 shows

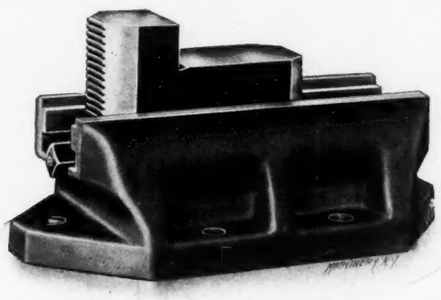


Fig. 1. Faceplate Jaw with Various Facilities for Clamping

them set in until their ends meet, in which position they may be used for holding comparatively small work. If the ordinary type of faceplate jaw were set in to the position shown in the illustration, obviously it would be impossible to clamp the inner ends as the bolt holes would be beyond the end of the T-slot in the faceplate. The pockets of this new design, however, make it easy to rigidly fasten the inner ends by simply using a strap and bolt between each pair, as the engraving indicates. These pockets also make it possible to set the jaws out to such a large radius that the outer ends overhang, as straps can then be employed, as illustrated in

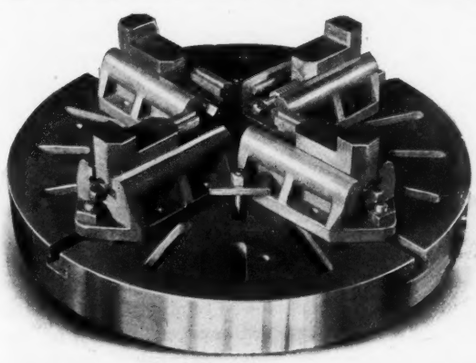


Fig. 2. Jaws Mounted on Faceplate in Position for Holding Small Work

Fig. 3, in place of the end bolt. It should be mentioned that the inner ends of the jaws are beveled to an angle of 45 degrees, so that they will fit together and support one another, when in the position shown in Fig. 2. The screws by which the sliding jaws are operated are of large diameter, and both the jaws and screws are of the same general proportions found in the heavy pattern independent chucks made by this company. The screws are provided with double thrust bearings, which reduce the wear and resulting end play to a minimum. These faceplate jaws are made either of gray iron or of true machinery steel castings, as desired. Any form of groove or rib, or double ribs, will be furnished so that the jaws will accurately fit the slots of the faceplate for which

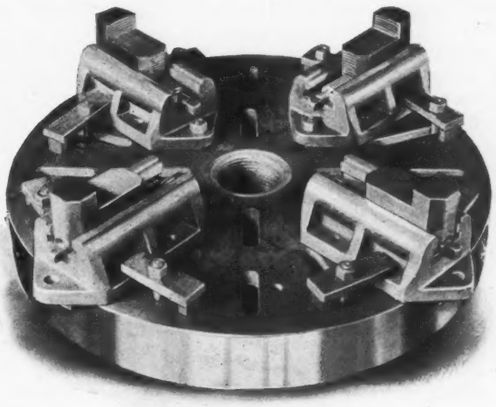


Fig. 3. Jaws set out so that Ends Overhang

they are intended. The company is also prepared to furnish special jaws for holding odd-shaped pieces, if these are required.

STANDARD IMPROVED OIL TUBE DRILL

The Standard Tool Co., Cleveland, O., has placed on the market a new oil tube drill which differs from the drills of this type formerly manufactured by this company in having steel tubes for conveying lubricant to the drill point, instead of brass. The advent of drills made from high-speed steel, with their increased speed and heavy cuts in refractory metals, proved too severe for brass oil tubes, which were too readily cut and pulled out of place, for satisfactory results. The steel tubes show a marked improvement over those of brass, and after a thorough and exhaustive test under the most severe conditions, the oil tube drill equipped with steel tubes has proved thoroughly efficient and reliable. These steel tubes are

Standard Tool Co.'s Oil Tube Drill with Steel Tubes

fitted to connect with a hole bored through the shank of the drill. This hole in the shank, with which connection is made to the oil supply, as well as the tubes themselves, may be seen in the accompanying illustration. The oil is forced through the hole in the drill shank and flows through the steel tubes, thus giving a constant supply at the cutting edges which keeps them cool and forces out the chips. The use of this type of drill will be found exceptionally satisfactory where deep holes are to be bored in steel or wrought iron. They can also be used to advantage in screw machines or in any tool fitted with means for supplying the lubricant. If necessary, the hole in the shank can be threaded for pipe connection.

ROCHESTER HORIZONTAL BORING, DRILLING, TAPPING AND MILLING MACHINE

The horizontal boring, drilling, tapping and milling machine illustrated in Fig. 1 is the product of the Rochester Boring Machine Co., Rochester, N. Y. This machine is electrically driven and it is so arranged that it can be started, stopped or reversed independently of the motor, these movements being controlled through friction clutches operated by a lever conveniently located on the saddle. Either the spindle, column or the saddle can be traversed by hand or power and with a fast or slow motion, as desired. All the operating levers and handwheels are located on the saddle, thus making the control of the machine convenient to the operator. The spindle is so arranged that the full traverse can be obtained without resetting and it is journaled in long phosphor-bronze bearings

located at each end of the saddle, that are adjustable from the outside. All the driving and feed gears are either of nickel steel, cast steel or manganese bronze and the feeding and driving mechanism is enclosed in the saddle and thus fully protected.

The motor, which is of the constant speed type, is mounted on top of the column and drives through rawhide and steel gearing to a vertical splined shaft which transmits the power to the driving mechanism in the saddle. Secured to this vertical shaft are the two friction clutches by means of which the machine is started, stopped or reversed by a starting lever on the saddle. When these clutches, which are shown at *A* and *B* in Fig. 2, are in the neutral or central position, no power is transmitted and the driving mechanism of the saddle remains at rest. When clutch *B* is engaged, forward motion is imparted to the bar, while the engagement of clutch *A* operates in the reverse direction. Through the bevel gears with which these clutches are connected, driving power is transmitted from the vertical shaft to the speed change gears *C*. These change gears by means of a tumbler gear arrangement in combination with back-gearing, give ten speed changes for the spindle, ranging from 15 to 200 revolutions per minute in geometrical progression. The intermediate shaft carrying the clutches for driving the back-gearing, has on it a pinion that meshes with and drives the large gear *A*, Fig. 3, through which the spindle is rotated by means of two splines which engage with it. The sleeve *B*, on which this gear is mounted, has a bearing in the saddle, and as clearance is provided between the bar and the sleeve, any vibration from the gears is not transmitted to the spindle.

The Feeding Mechanism

The arrangement of the feeding mechanism is also shown in Fig. 3. The sleeve *B* has teeth cut in one end which mesh with three pinions *D*, driving a planetary gear *E*. This planetary gear, in turn, by means of pinions *N*, transmits the movement to the rotary nut *L*, which engages directly with the spiral cut in the spindle. This nut has a heavy flange which rotates between large ball thrust bearings, as shown, in order to take the end-thrust from the bar in either direction. When the feed is disengaged, this nut rotates at the same speed as the spindle, with the result that the latter remains in a fixed position. By an ingenious arrangement of the planetary gear system, whereby connection is made with the feed gearing *G*, a differential rotation can be given to the nut *L*, causing it to be either advanced or retarded. Either advancing or retarding it effects the traverse of the spindle, which is thus caused to move in the direction desired. These feed change gears are driven from the intermediate shaft which drives the gear *A* for the spindle. When the feeds are disengaged, gear *F* in which the planetary pinions *D* are mounted, does not rotate, and the nut *L* rotates with the spindle which therefore remains in the same longitudinal position. When, however, the gear *F* which is connected indirectly with feed change gears *G* is driven by these gears, a forward or reverse rotation, as desired, is given to nut *L* (independent of the drive), and consequently a feeding movement to the spindle. The feed change gears are arranged with back-gears, and eight different feeds for the spindle are available, ranging in geometrical progression from 0.01 to 0.25 inch per revolution of the spindle. This power feed is controlled by a friction clutch which is engaged or disengaged by the clamping nut *I*. The feed can be reversed when desired, and all the feed operating levers are mounted on the saddle, a detail of which is shown in Fig. 4. The eight feed changes are obtained by means of the levers *A* and *E*, while the feed is reversed by a lever *C* located back of the handwheel used for feeding the spindle by hand.

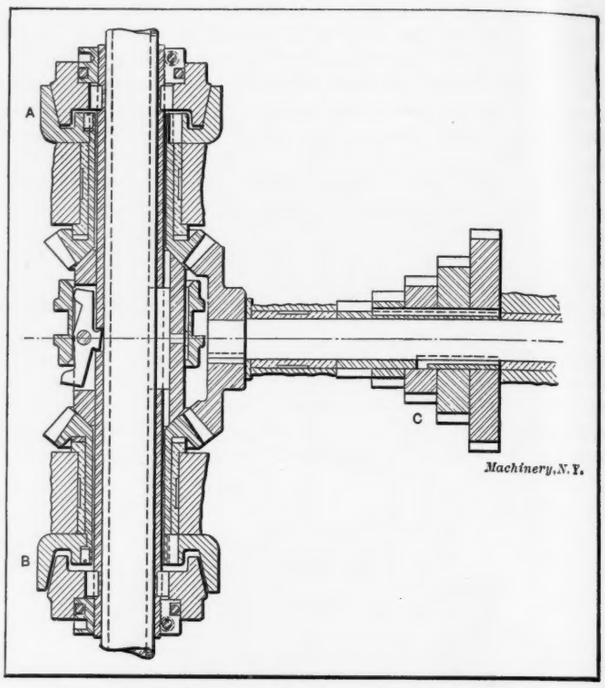


Fig. 2. Friction Clutches by means of which Machine is started, stopped and reversed

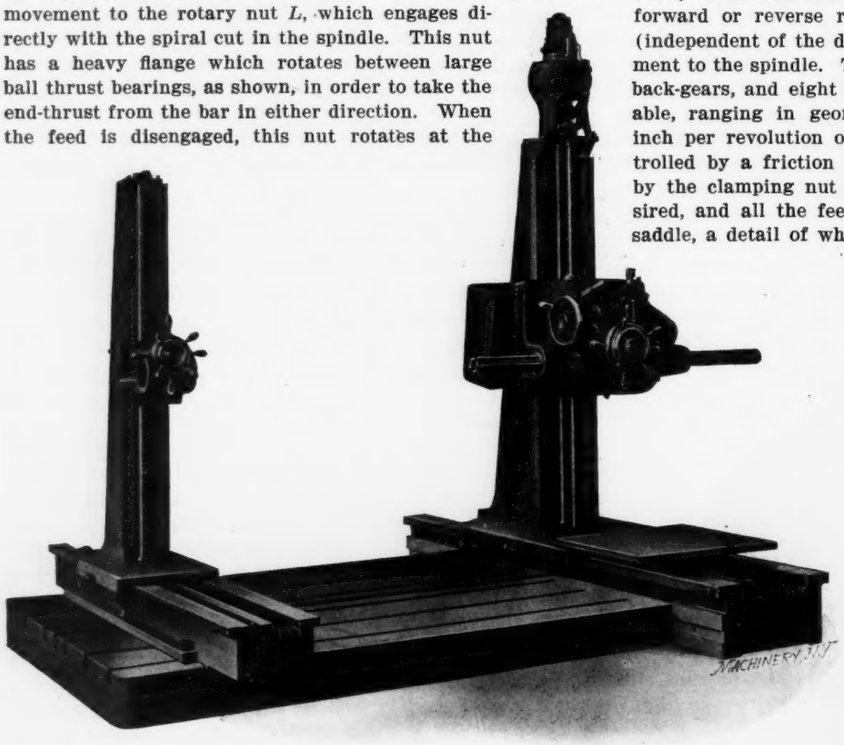


Fig. 1. Rochester Horizontal Boring, Drilling, Tapping and Milling Machine

Milling Feeds for Column and Saddle and Rapid Traverse

On the saddle two concentric pilot wheels *F* and *G* are mounted. The inner wheel *F* is mounted on a hollow shaft, which, through gearing, operates the traverse of the column, and the outer wheel *G* controls the motion of the saddle on the column. The inner wheel, which is free to slide on the hollow shaft, is provided with a double-end clutch so that pulling it outward engages a clutch on the outer handwheel through which power drive is transmitted to a rotating nut on the elevating screw which elevates the saddle. By pushing the wheel *F*, to its inner position, a clutch fixed on the hollow shaft is engaged and the vertical shaft for traversing the column is driven. As these gears connect with the feed change gears (without the back-gears) four feed changes are available in either direction for traversing the saddle or column when milling. Means are also provided for obtaining a positively-driven rapid traverse of 6½ feet per minute for the saddle, column and spindle. Whether the milling feed or the rapid traverse is engaged, depends on the position

of lever *H*. When this lever is moved over to the left, the feed gears are engaged; when it is in the middle or neutral position, as illustrated, the drive is inoperative, and when it is moved to the right, either the column or saddle may be rapidly traversed. The vertical shaft for traversing the column along its bed, transmits the motion by a pinion meshing into a rack in the base slide. This convenient arrangement for traversing the spindle, saddle, and column in any direction, in conjunction with the convenient means for starting, stopping or reversing by the manipulation of lever *J*, greatly facilitates the operation of the machine and effects a great saving in time and labor.

Miscellaneous Features

The saddle is counterbalanced by a weight sliding on the back of the column, and it is guided by large flat bearing surfaces carefully scraped to perfect contact. The bearing on the outboard column for supporting the boring-bar is also traversed by concentrically-arranged handwheels similar to those on the saddle, which are operated by hand only. The saddle column, as well as the outboard support column, has solid wedge gibs and clamping devices for locking them to the bed in any position. The slide base for the main column is provided with a groove on the side for accurately locating the floorplate, and both bases are strongly reinforced by internal ribs. The baseplate of a standard machine of the size illustrated is 6 by 9 feet, but this dimension can be varied to suit individual requirements. This floorplate is of heavy box type construction and it is rigidly attached to the slide base by means of heavy bolts.

The rated horizontal traverse of the column for this size machine is 6 feet, but it can be safely operated laterally over a distance of 7½ feet. One of the noteworthy features of this machine is that the whole length of the spindle can be used for the feed without resetting, thus giving any required range of continuous feed by using the proper length of bar. If desired, two or more bars can be furnished and also special bars in various lengths. The spindle of the machine is bored to receive a No. 5 Morse taper, but different tapers can be provided in the two ends of the bar if desired, and the latter can be readily reversed if necessary. One end of the bar can be threaded for holding milling cutters when this is required. The makers claim that owing to the absence of friction, the feed is so sensitive that small drills can safely be used even on the largest machines. Graduated scales with vernier attachments are provided for the column and base slide, as well as for the outboard support and slide. These scales are, of course, a great convenience for quickly adjusting the machine and for spacing known distances on the work. The spindle feed handwheel is also equipped with a micrometer, by the aid of which adjustments can be made to within 0.001 of an inch. This micrometer reading is very useful in gaging depths in boring, drilling and milling.

The shafts of this machine are all journaled in phosphor-bronze and the sleeves are provided with felt oil pads. A high grade of steel is used for all shafts, and cap-screws, set-screws, nuts, operating levers, etc., are casehardened. The equipment furnished with the machine includes, in addition to the machine itself complete with motor, a floorplate, outboard support, graduated scales and the necessary wrenches, spanners, etc. Special tables, boring-bars, parallels, cutters,

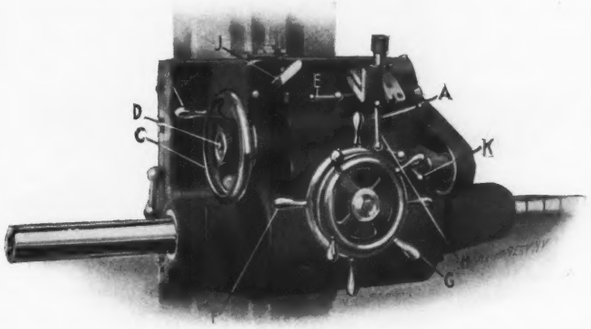


Fig. 4. View showing the Operating Levers on the Saddle

etc., will be furnished extra if desired. The company is also prepared to build, in addition to the standard type illustrated herewith, special designs arranged to meet any feasible condition.

BROWN & SHARPE BEVEL PROTRACTOR

An improved bevel protractor has recently been placed on the market by the Brown & Sharpe Mfg. Co., of Providence, R. I. This protractor, which we illustrate herewith, is an accurate and inexpensive tool that is not only useful to mechanics, but is also of great service to draftsmen.

The design of this tool is simple, and it is similar to the improved universal bevel protractor made by the same company. The principal difference between the two tools is that there is no vernier on the new protractor, so that measurements cannot be made to such a degree of fineness as with the universal protractor; it is intended, however, for work not requiring great precision.

To facilitate the use of the tool, one side of the protractor is flat which allows the tool to be laid flat on the paper or work—a decided advantage that users of the protractor will appreciate. The dial is graduated in degrees and these graduations extend over an arc of 180 degrees, reading from zero to 90 degrees from each extremity of the arc. Especial care is taken with these graduations to have them accurate. The large central stud upon which the dial of the protractor turns, is hardened in order to eliminate as much wear as possible. When the protractor is set and the nut tightened, it clamps the dial rigidly in position so that there is no danger of slipping.

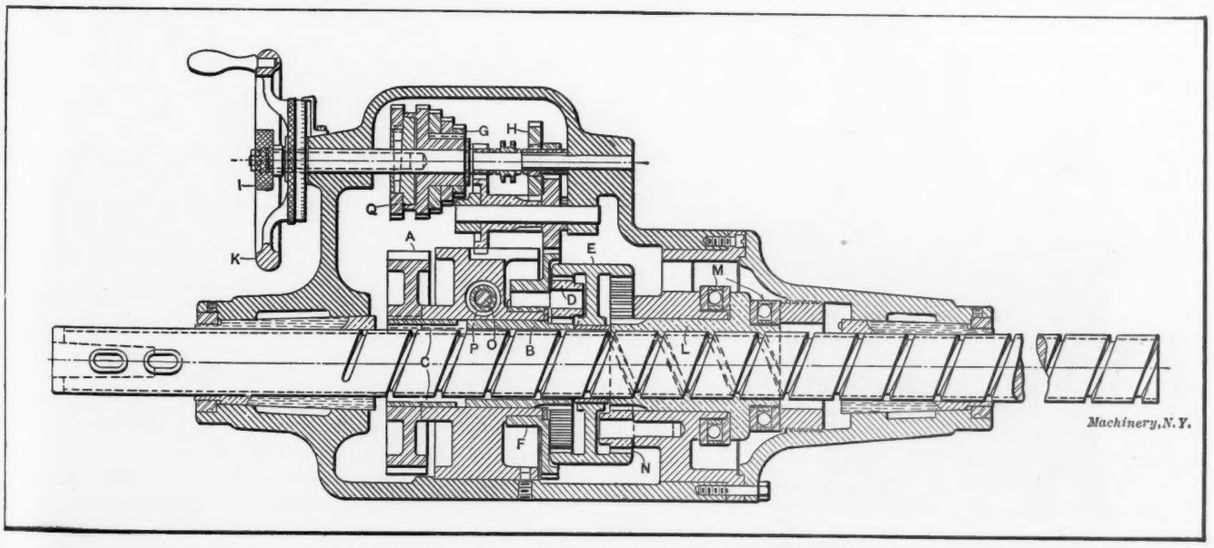
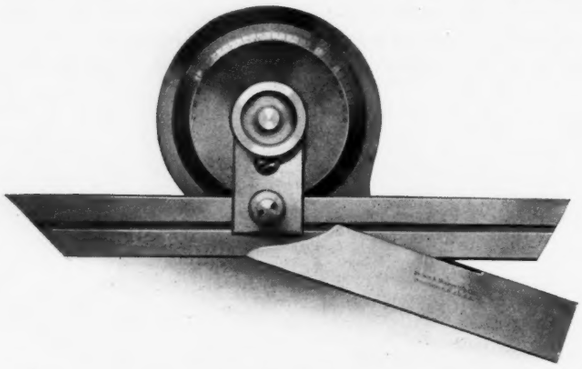


Fig. 3. Sectional View of Saddle, showing Feed-changing Mechanism

The blade of the protractor is free to move backward and forward for its entire length, independently of the dial, which feature adapts it to a wide range of work. This blade is



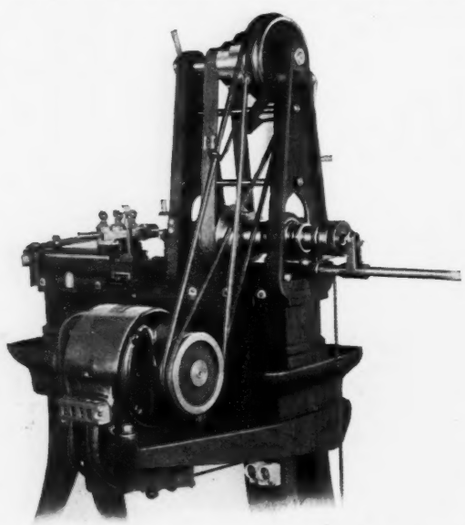
Brown & Sharpe Bevel Protractor for Mechanics and Draftsmen

clamped independently of the dial and is rigidly held in place. Great care has been taken in cutting the grooves, etc., so that there is very little chance for dust to accumulate and cause inaccuracies in the measurements.

GARVIN MOTOR-DRIVEN SCREW MACHINE

The standard No. 1 screw machine, which the accompanying engraving illustrates, is the type regularly built by the Garvin Machine Co., Spring and Varick Sts., New York City. This particular view shows the machine equipped with a motor drive, the motor being mounted on a bracket at the rear so as to form an integral part of the machine. The manufacturer's idea in using the regular stock machine for attaching the motor drive is of twofold benefit. In the first place, orders can be executed more promptly, and, in the second, a motor-driven portable machine, that can be set anywhere in the factory to suit conditions, can be obtained at moderate cost.

The main belt connecting the upper and lower cone pulleys can be made endless, as the eccentric adjustment provided for the upper cone, which runs loose on a shaft, makes it possible to obtain sufficient tension to transmit the required power for operating the machine. As this adjustment is quickly

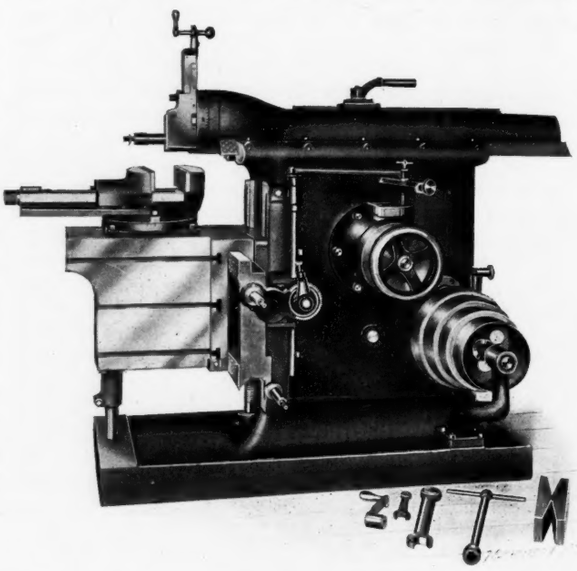


Garvin Screw Machine equipped with Motor Drive

operated, it may be used for slacking the belt prior to shifting it for obtaining speed changes. The straight and crossed belts that are used to connect the motor with the upper cone pulley, are under the control of the shipper handle shown projecting in front of the machine. These belts, which are ½ inch in diameter, run on a system of three grooved pulleys overhead, those on the outside being loose pulleys and the one in the center, tight. The machine is started and stopped from the front side, thus making the control convenient to the operator. A half-horsepower motor is used to drive the machine, the motor running at 1600 revolutions per minute. This machine has a capacity for stock up to 5/8 inch in diameter through the spindle, which is equipped with automatic wire feed. The weight complete, when skidded for shipment, is 600 pounds.

IMPROVED MILWAUKEE SHAPER

The shaper illustrated herewith, which is known as the "Milwaukee" shaper, is built by the Lutter & Gies Co., Milwaukee, Wis. It has been the aim of the builders of this machine to secure, both as to general design and workmanship, strength and simplicity in all the working parts. The base is of the pan design and it is strongly ribbed inside to insure stiffness. It also projects well out from the column and affords a rigid foundation. The column is also of liberal dimensions and rigidly braced. As the engraving shows, the slides overhang at both ends, giving long bearing surfaces to the ram. The ram has a quick return and it is strongly constructed. It is provided with eight speeds, four being obtained by a four-step cone pulley, which number is doubled by the back-gears that are engaged by means of a lever at the back of the machine. The table is slotted on both the top and



Twenty-four inch Shaper built by Lutter & Gies Co.

the sides, and it has a working surface of 18½ by 15 inches on top, and 16½ by 14 inches on the side. By loosening the bolts which fasten the table to the apron, it may be revolved to any position that may be required. This is a valuable feature which adapts the tool particularly for tool-making and die work. When the table is removed, either the vise or the work itself can be clamped directly to the front of the apron, T-slots being provided in this surface. The vise has a graduated swivel base, and it can be clamped at the side of the table as well as on the top. The tool head is also graduated and it swivels to any angle. The vertical feed is provided with micrometer adjustments. The length of stroke can be changed instantly from the working side of the machine by simply manipulating the large handwheel shown. Just what the stroke is at all times is indicated by a pointer located near the handwheel. The feeding mechanism is simple in construction, the movement being transmitted from a slotted crank to a vertical splined shaft, which is connected through bevel gears to the ratchet shaft. An adjustable table support is provided for eliminating all spring from the table when doing heavy work. All bearings such as those of the ram, apron, and slides are provided with taper gibs to permit the maintenance of the accurate fit originally given to these parts. The cross-rail screw has ball thrust bearings and a micrometer collar reading to thousandths of an inch. The elevating-screw nut for the saddle, is provided with ball bearings to eliminate friction as far as possible. The machine can be conveniently used for keyseating, as there is an opening

under the ram large enough to allow the passage of a shaft 3 inches in diameter. The stroke of this shaper is 24½ inches. The automatic cross traverse is 29½ inches and the downward feed in the tool head, 11 inches. The table has a vertical adjustment of 11¾ inches, and the vise has a maximum opening of 15⅜ inches. The net weight of the machine is about 4000 pounds.

COLBURN 24-INCH HEAVY-DUTY DRILL PRESS

A heavy-duty drill press that is of unusual interest, not only because of its constructional features, but also by reason of the results in the way of rapid drilling which it makes possible, was exhibited at the recent convention of the American Railway Master Mechanics' and Master Car Builders' Associations at Atlantic City. This tool, which is the latest product of the Colburn Machine Tool Co., Franklin, Pa., can be arranged for either belt or electric drive. Fig. 1 illustrates the electrically-driven machine that was used by the Celfor Tool Co., at the convention referred to, for demonstrating its high-speed twist drills, and which will be installed in its plant at Buchanan, Mich., for drill testing.

These machines are built on the unit system, that is the speed changing mechanism is in one separate box, the feed change gears are enclosed in another separate case, and the head is another unit, entirely independent of the other parts. The advantages of this method of construction, not only in the manufacture, but also in connection with repair work, or in the location of any defects that may develop, are well-known.

All gears used on this machine either run in a bath of oil or are made of steel and hardened. This includes the main

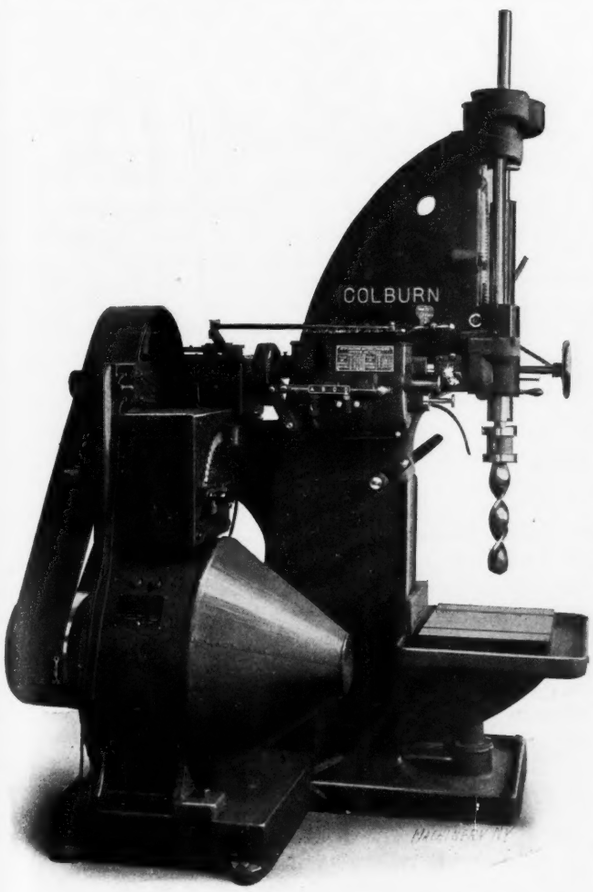


Fig. 1. Colburn 24-inch Heavy-duty Electrically-driven Drill Press

driving gears for the spindle, the bevel gears connecting the vertical intermediate shaft with the horizontal shaft at the side of the column, and the two gears connecting this latter shaft with the speed box. The main driving gears through which power is transmitted to the spindle, are helical gears which are comparatively noiseless in operation. These gears are made of steel and the teeth are ground in to insure smooth running. The gears connecting the speed box with the shaft passing through the feed box at the left side of the column, are also of the helical type and hardened.

The Driving Mechanism

The drive is through a single constant speed pulley, which is equipped with a friction clutch, by means of which the machine is started and stopped. The speed change mechanism is encased in an oil-tight box, which is filled with oil so that all the gears and bearings inside it are perfectly lubricated. All the speed changes, of which there are eight, ranging from

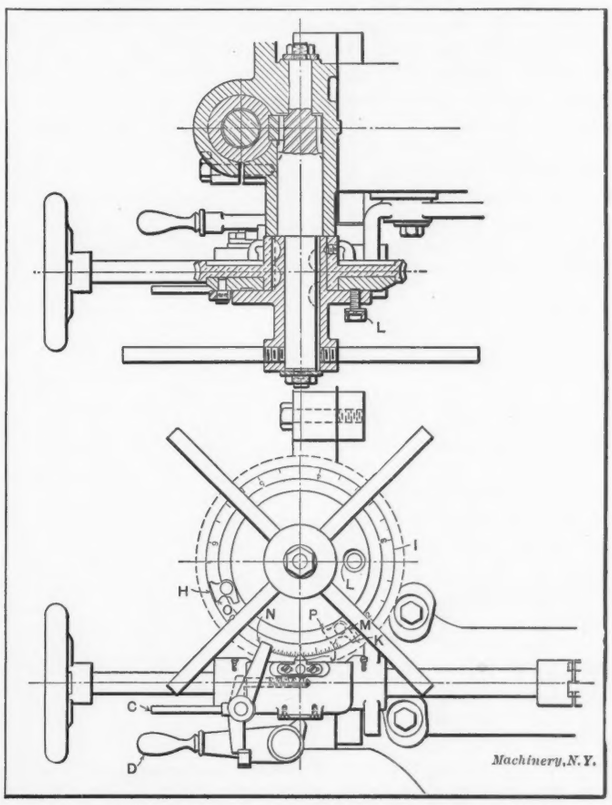


Fig. 2. Section and Elevation showing the Automatic Feed-tripping Mechanism

40 to 440 revolutions per minute, are made by two levers, conveniently located at the front of the machine. Four of these changes are effected by the engagement of a hardened dive-key with different gear combinations, while the remaining four are obtained through back-gears. The gears for the speed changes and also those in the feed box are lined with hardened steel bushings. The drive to the spindle is simple, power being transmitted through short shafts, the bearings of which are close together. The arrangement of the drive is similar to that used in recent vertical milling machine construction.

The Feeding Mechanism

All the feed changes are obtained through positive gears that are also encased and run in a bath of oil. A range of six feeds is available, which vary in geometrical progression from 0.006 to 0.040 inch per revolution of the spindle. These changes are made by means of a dive-key and back-gears. The feeding movement is transmitted to the spindle through a worm-gear of large diameter. This gear has mounted on it a dial graduated in thirty-seconds of an inch, that enables the operator to accurately measure the depth drilled. As these graduations are about ⅛ inch apart, obviously, finer measurements than 1/32 inch may be made by reading between the graduations. This dial, which is adjustable, is provided with a pawl that can be set to trip the feed at any point in 14 inches of the spindle travel, or if desired, the feed may be tripped by hand from the operator's position. A safety shear pin that is placed on the worm shaft protects the feeding mechanism from injury.

The Automatic Trip Mechanism

A detail view of the automatic trip mechanism is shown in section and elevation in Fig. 2, and the method of its operation

is as follows: If the feed is to be tripped automatically in 7 inches or less, pawl *H* is set as indicated by the dotted lines at *K;* if it is desired to trip the feed at a distance greater than 7 inches, pawl *H* is turned to the position shown by the full lines. For example, if it should be required to automatically trip the feed at a depth of 3 inches, the knurled nut *L* would first be loosened and the graduated dial *I* turned until the figure 3 on it was opposite the mark on pointer *J*, after which nut *L* would be tightened. The pawl *H* would then be set in the position shown by the dotted lines, with the result that when the drill had traveled 3 inches, the surface *M* would come in contact with the side *N* of the trip arm and disengage the feed. If, on the other hand, it were required to drill to a depth of 9 inches before the feed was automatically tripped, the dial *I* would be set with figure 2 opposite the mark on pointer *J*, and pawl *H* would be turned to the position shown by the full lines. With the pawl in this position, the contact of surface *O* with lever *N* would not throw out the feed, as the pawl, being loose on its stud, would simply turn and pass the tripping arm without moving it. After the pawl had passed the arm, it would then be in the position shown by the dotted lines, that is with the end *P* correspond with those on the indicating plate. The six feeds are obtained by operating this rod in conjunction with pull-rod *X*, which is connected with the back-gears in the feed box. The lever *C* to the right of the machine, may be used to trip the feed by hand, while lever *D* throws the feed in after it has been tripped. The handwheel *E* operates the hand feed, the power feed being disengaged by pulling out this wheel and its shaft which disengages clutch *F*. The capstan handle *G* is for the rapid traverse of the spindle, the worm and gear being first disengaged by means of lever *C*. It will be seen that all the operating levers are conveniently placed; in fact, they are all within a space of 1 foot in height by 2 feet in width.

Miscellaneous Constructional Features

This machine is equipped with a lubricating system, the lubricant being taken from a tank which is located at the side of the machine. The pump is attached directly to the machine frame, and it is driven by a small round belt from the pulley hub. The lubricant, after being forced through the flexible nozzle onto the work, drains back through a strainer into the tank.

The table is of the bracket type and it is provided with extra large bearings on the column. It has a vertical adjustment of 15 inches by means of a large telescope screw that is operated by a crank at the front. This screw has been set off center to permit a boring-bar to pass through the table. The working surface of the table, which is 18 by 24 inches, contains two T-slots, and a large oil pan is provided on both sides and in the front.

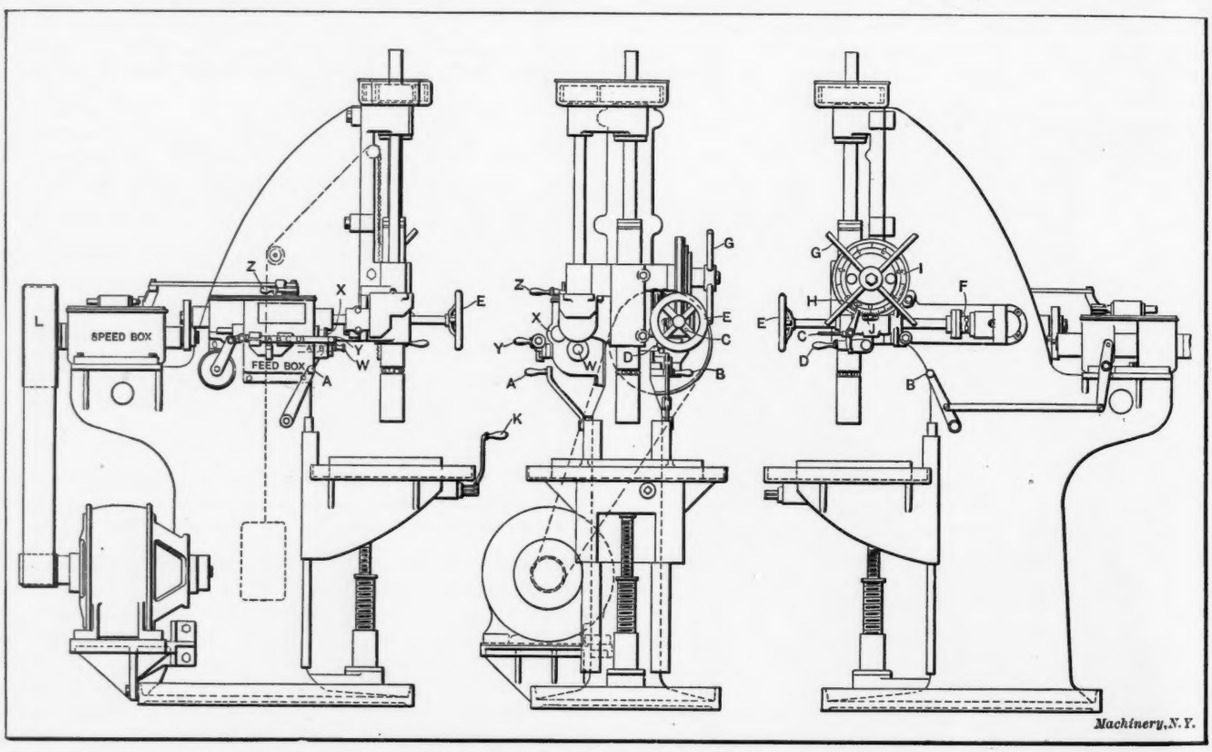


Fig. 3. Elevations of a Motor-driven Machine

in contact with a projecting sleeve, thus preventing further rotary movement, so that when it again came around to the tripping lever, the feed would be disengaged. As one revolution of the dial is equivalent to a depth of 7 inches, it will be seen that by this simple arrangement, the feed is automatically controlled throughout a range of 14 inches. If the knurled nut *L* is loose, the feed cannot be automatically tripped at any point.

Operation of the Machine

The function of the various operating levers will be explained in connection with the elevation shown in Fig. 3. The levers *A* and *B* at each side of the column serve to start and stop the machine through the friction clutch pulley *L*. The lever *Z* mounted just above the feed box, operates the back-gears of the speed change mechanism, while handle *Y* controls the position of the dive-key in the speed box and gives four changes of speed which are indicated by raised letters, A, B, C, and D, which correspond with similar letters on an indicating plate that may be seen in Fig. 1. As before stated, these four speeds are doubled by means of the back-gears. The pull-rod *W* operates the dive-key for the feed changes, and its position is also determined by letters which

The spindle of the machine is of forged high-carbon steel, and the thrust is taken on Hess-Bright ball thrust bearings. The spindle has a travel of 16 inches, and the end is bored to receive a No. 5 Morse taper. The maximum distance from the nose of the spindle to the table is 34 inches, and the distance from the center of the spindle to the face of the column is 12½ inches.

Tests

Tests made with the motor-driven machine illustrated in Fig. 1 which is equipped with a 25-horsepower constant speed, Westinghouse motor that is connected to the clutch pulley of the drill press by an 8-inch belt, showed a capacity for rapid drilling that exceeded the expectations of the designers. For example, in a test conducted by the Colburn Machine Tool Co., a 1½-inch drill was driven at the rate of 31.2 inches per

minute, without injury to either the machine or drill, which illustrates in a striking way the power and strength of the machine. When, however, an attempt was made to use a little larger drill than this, the drill was burned. The makers believe, though, that it would be practical, when using a 1-inch drill, to drill holes in ordinary cast iron at a feed rate of 31.2 inches per minute. Another interesting experiment was made with a 3-inch drill, which was driven through cast iron at 11.25 inches per minute. The cutting speed was then increased from 147 feet to 262 feet per minute, without changing the feed, which gave a feed rate of 15.7 inches per minute. After the drill had penetrated to a depth of 3 inches, the fuse blew out, at which time the power consumption was 53 horsepower. Of course, this kind of drilling is not advocated, but was simply done to demonstrate the capacity of both machine and drill.

When the machines are electrically driven, the constant speed type of motor is employed. This motor is mounted on an extension of the base at the rear of the machine where it is out of the way. As the motor is located beneath the feed change box, there is practically no increase in floor space required when the motor drive is employed, as is plainly shown by the front elevation, Fig. 3. The manufacturers recommend a belt drive direct from the motor to the driving clutch pulley; this allows the machine to be started and stopped by means of the clutch without stopping the motor. Any make of constant speed motor can be used and the size should range from 5- to 20-horsepower, depending on the work to be performed.

FLICKINGER COMBINATION GAS ENGINE AND AIR COMPRESSOR

A combination gas engine and air compressor for supplying, simultaneously, power and compressed air, is now being manufactured by the Flickinger Iron Works, Bradford, Pa. Both the engine and compressor operate as a combined unit, one end of a single cylinder being used as an explosion chamber for developing the required power, while the other acts as a compressor. The arrangement is such that the machine can be instantly converted into a simple gas engine while running, and the compressor can also be thrown into commission at any time. This feature would be especially applicable to shops requiring power continuously and compressed air intermittently.

Exterior and sectional views of this gas-driven compressor are shown in Figs. 1 and 2, respectively. The gas engine or

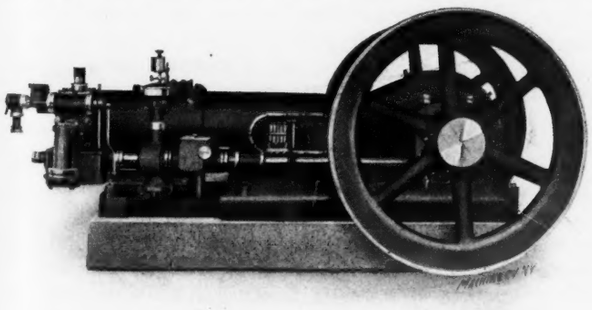


Fig. 1. Gas-driven Compressor which may be used as a Motor and Compressor, simultaneously

power end of the machine works on the four-cycle principle and it is identical in construction with the gas engine manufactured by this company. The special feature of this engine is the valve mechanism which consists of an automatic cut-off valve, controlled by a governor. This governor is of the centrifugal ball type, and the arrangement is such that the charge is throttled in proportion to the load. The ignition system used depends on the requirements, either a Bosch magneto, jump spark, or make-and-break system being employed. When the magneto is installed, it is mounted on the engine frame and driven by a transmission chain, connecting with the secondary shaft so as to make only one revolution for each spark. This spark can be advanced or retarded while the engine is running, and the same intensity of spark is produced when starting as when running at full speed.

The air compressor end of the cylinder is equipped with a mechanically-operated intake valve, which is similar to the Corliss engine valve. This valve, which is plainly shown in the sectional view, is at rest during the entire compression

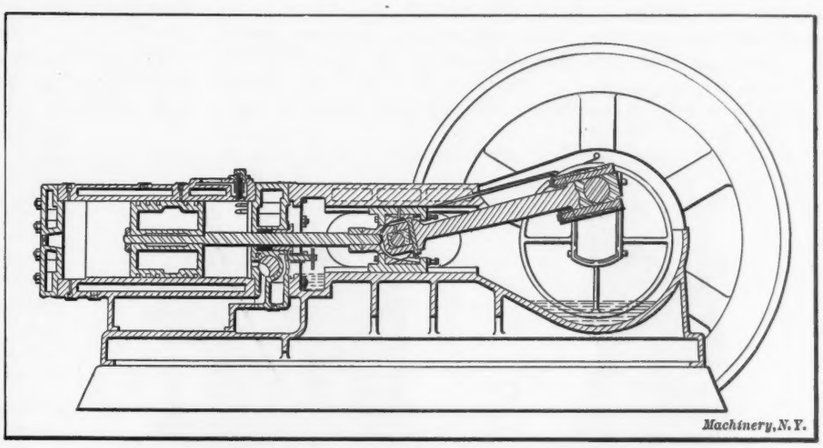


Fig. 2. Sectional View of the Combination Gas Engine and Compressor

stroke, which minimizes the wear. The discharge valves are of the standard poppet type, and have removable guides which can be taken out without breaking any pipe connections. The valves on the motor end of the cylinder are of the mushroom type. The exhaust valve is operated by a cam on the lay-shaft, while the inlet valves are opened by the vacuum created during the suction stroke. These valves, which are provided with dash pots to insure smooth working and easy seating, are so arranged that the incoming charge strikes against and cools the exhaust valves. The cylinder is furnished with a water-jacket throughout its entire length, and the front and back heads are also water-jacketed. The bed is of the bored-guide type and the main bearings are provided with interchangeable bronze liners which can be renewed at any time. The crankshafts are of the center-crank type and the journals are ground true on a special machine. The connecting-rods are forged from solid steel billets and are provided with a screw and wedge take-up on the cross-head end, and solid bronze boxes. The crank end is of the marine type and has steel boxes lined with genuine babbitt metal. All parts are made of high-grade material and the engine is rigidly constructed throughout.

These machines are built with single cylinders in sizes up to 50-horsepower. They are also made in the duplex and tandem types up to 100-horsepower and with the duplex tandem arrangement in larger units. The duplex engine can be furnished with only one side fitted with a compressing cylinder, if the power requirements are greater than those of the air.

ELMORE SENSITIVE DRILL PRESS

A very compact and conveniently-operated sensitive drill has been brought out by the Dwight Slate Machine Co., Hartford, Conn. This machine, while in the "sensitive" class, has been rigidly and substantially constructed to enable it to meet the demand for the higher speeds which the new alloy steel drills now employed have made possible and desirable.

Perhaps the most striking feature of this new design is the form of belt drive employed. This drive is so arranged that several changes of speeds may be quickly obtained while the machine is in motion, without leaving the operating position, or shifting the belt either on cones or in tension. By referring to Figs. 1 and 2, which show, respectively, single and multi-spindle machines, it will be seen that connection from the pulleys on the drive shaft to the pulleys on the spindle, is made by an endless belt. This belt, which is 1¼ inch wide and

17 feet long, passes around two driving pulleys of different diameters at the rear, and over suitably arranged idlers to two driven pulleys on the spindle. Between each of these sets of pulleys, friction clutches have been interposed, the clutch for the spindle being operated by the small crank seen near the top of the column, and the clutch for the driving pulleys by a similar crank located on the column just opposite the driving shaft. It is by means of these levers, which are self-locking in all positions, that the speed changes, of which there are four ranging from 500 to 2050 revolutions per minute, are obtained. The lower lever, which operates the clutch between the driving pulleys, also controls the starting and stopping of the machine. This construction, therefore, makes it possible to start and stop any spindle of a multi-spindle machine, independently of the others. This independent feature makes it unnecessary to employ tight and loose pulleys, the machine being equipped with constant speed drive on a single pulley.

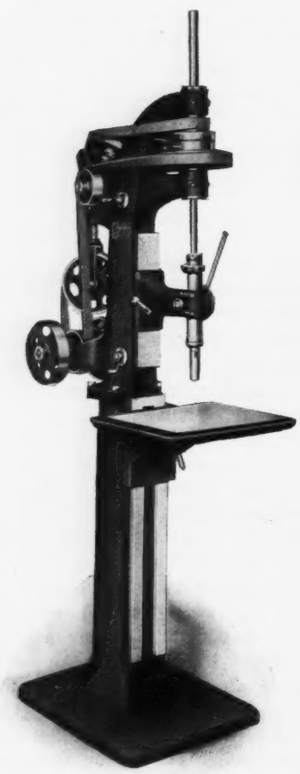


Fig. 1. Single-spindle Sensitive Drill Press, built by Dwight Slate Machine Co.

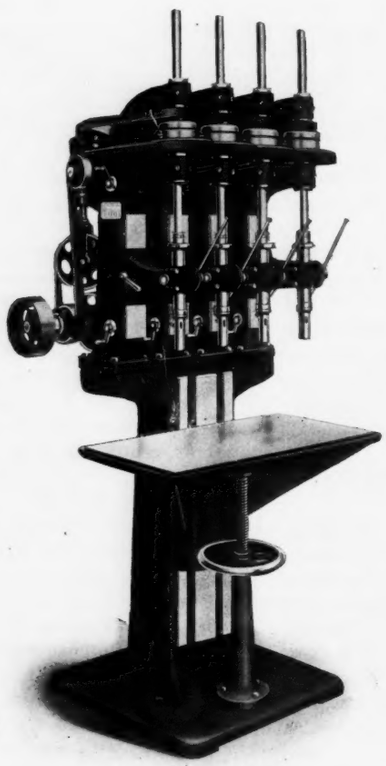


Fig. 2. A Dwight Slate Machine of the Multi-spindle Type

An indicating plate, which is attached to the column, shows graphically the relative positions of the upper and lower clutch handles for obtaining the various speeds. For example, when both handles occupy a vertical position both clutches are disengaged; by moving the lower one to the left and the upper one to the right, a speed of 500 revolutions per minute is obtained; by shifting the lower one also to the right, this speed is increased to 800 revolutions per minute, etc.

The pulleys on both the driving shaft and spindle are mounted on stationary hollow quills, which arrangement relieves both the spindle and driving shaft from all belt stress. The proper tension of the belt is obtained simply by turning a knurled nut through which the screw of the idler yoke at the rear passes.

The spindles of these machines are bored with a No. 2 Morse taper hole and each spindle is counterbalanced by a flat coiled spring located in the sliding head. These springs can be adjusted to exactly counterbalance the spindle, or so as to automatically return it to its upper position. The feeding lever may be easily moved in or out for obtaining varying degrees of leverage, and it is automatically retained in any position desired by the same spring which counterbalances the spindle. Positive depth stops are mounted on each spindle quill within easy reach of the operator.

In order to make frequent oiling unnecessary and to eliminate friction as far as possible, ball bearings are used throughout. All cones and raceways are carefully hardened and ground. The clutches employed are of the simple cone type and are of large proportions, considering the duty imposed on them.

As each unit of a multi-spindle machine may be operated independently of the others, a continuous drive shaft connecting all the spindles may be used, in which case they would have the same ratio of speed changes. If it is desirable, however, an independent drive can be provided for each spindle by using varying sizes of pulleys on the lineshaft, so that the spindles can have a different speed ratio. For example, with a three-spindle machine, the speed of two of the spindles could be controlled by one drive shaft, thus providing a suitable ratio of speeds for the drilling operations, while the third spindle could be driven independently and at the proper speed for tapping, counterboring, facing and similar operations. This feature adapts the machine particularly to varied classes of work.

Another good point in the construction of this tool lies in its compactness, a comparatively small amount of floor space being required. The projected floor space for a single-spindle machine is only 20 by 33 inches, while that of one with 6 spindles is 34 by 63½ inches. As it is unnecessary for the operator to make adjustments at the rear, rows of these drills may be set back to back, thus effecting a considerable economy in the matter of floor space.

These tools are built with any number of spindles up to and including six. The distance from the center line of the spindle to the face of the column is 8 inches. The total traverse of the spindle is 13 inches, and the maximum distance from the table to the spindle is 32 inches on the single-spindle type, and 26 inches on the multi-spindle machines, which, as Fig. 2 shows, are equipped with a table-raising device. The approximate net weights of the single- and six-spindle types are 500 and 2150 pounds, respectively. The company is prepared to equip this tool with an electric drive if desired. When this form of drive is employed, the motor is mounted on a separate bracket which is attached to the rear of the column.

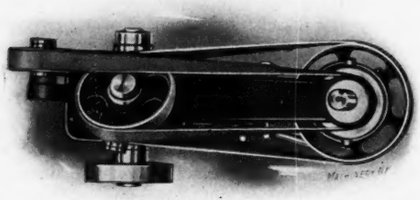


Fig. 3. Plan View of the Belt Drive

BAIRD TOOL AND DIE GRINDER

The Baird Machine Co., of Oakville, Conn., is now manufacturing the tool and die grinder illustrated in Fig. 1. This machine is intended as an all-around grinder for the tool-room or for general work, and it can be used for the grinding of punches, dies, automatic machine tools, lathe and planer tools, etc. It consists of a neatly designed column on which is mounted a tool steel spindle carrying an emery wheel on each end. An adjustable tool rest is provided for one wheel to support lathe, planer or similar tools, while beneath the opposite wheel there is a table on which may be supported punches, dies and similar tools while they are being ground. The bracket on which this table is mounted can be easily and quickly adjusted vertically on the column. It is clamped rigidly in the desired position by a cam and lever, and a counterweight connected with the bracket and contained in the pedestal, keeps it from falling when the clamp is released. This counterweight also makes it easier to raise or lower the bracket. In addition to the adjustment of the bracket on the

column, a fine adjustment is provided for the table that is obtained by means of the small handwheel shown in the illustration. This fine adjustment, which has a range of 1 inch, is desirable for the grinding of dies and similar work. The maximum adjustment of the bracket on the column is 12¾ inches. The construction of the spindle and its bearings is shown in Fig. 2. The spindle has ground taper bearings which run in bronze boxes, the composition of which is the same as that required by the United States Government for bearings. These boxes are dustproof and they have simple adjustments for taking up wear, as the engraving indicates. They are provided with ring oiling devices and they can easily be replaced with new ones when this is necessary. The height from the floor to the center of the spindle of this machine is 40 inches, and the distance between the wheels is 15¼ inches. The distance from the top of the table to the center of the spindle with the table and bracket in the lowest position, is 15¾ inches, and the surface of the table is 10 by 18 inches. Two emery wheels, 12 inches in diameter with a 1-inch face, a set of wrenches, water tank, and a countershaft are furnished with this machine. The countershaft is provided with a slotted lever shipper that is operated by simply twisting a rod, and it is locked in either the on or off position.

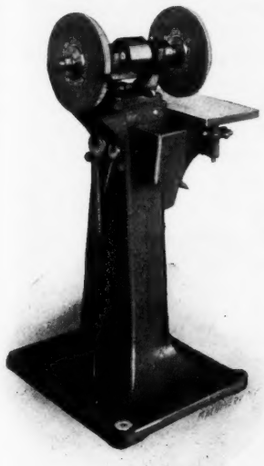


Fig. 1. Baird Tool and Die Grinder

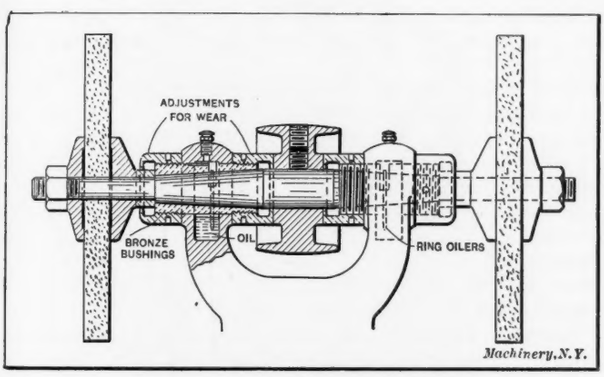
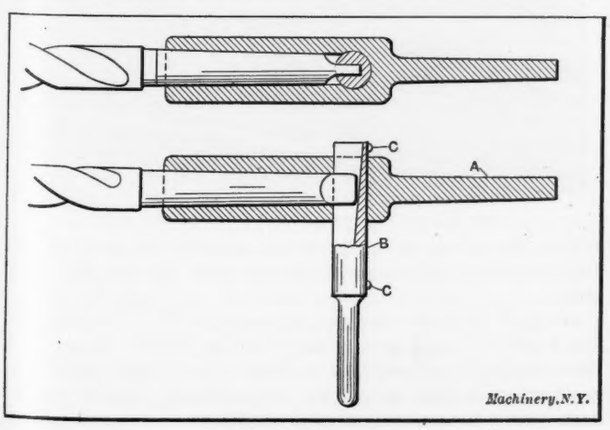


Fig. 2. View showing Construction of Spindle

LINSLEY LATHE DRILL HOLDER

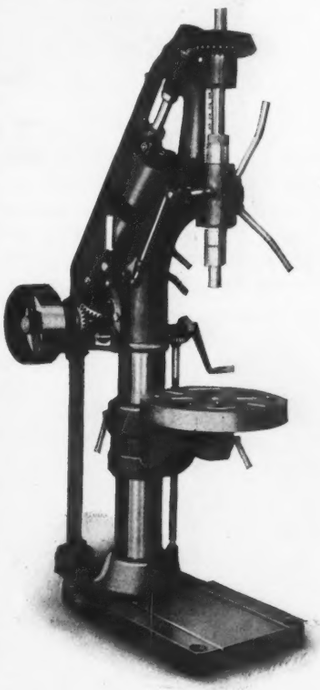
A drill holder for the lathe, which has been brought out by the Linsley Tool Co., 13370 Superior Ave., Cleveland, Ohio, is shown in the accompanying line engraving. The shank *A* of this holder is turned to fit the tailstock spindle, and the outer part or body is bored to fit the drill or tool-shank. A cross-shaft or pin *B* is provided, that slides loosely in a hole bored through the holder. This cross-pin has a groove cut in it, the sides of which extend down over the tang of the drill, thus preventing the latter from turning in the holder. As the bottom of this groove is cut on an incline, the pin *B* is also used to force the drill from the holder. When the holder is in use, the end of pin *B* rests on the lathe tool-rest. The two screw-heads *C* prevent the two parts of the holder from becoming separated when it is not in use.



Drill Holder for the Lathe

BARNES ALL-GEARED TAPPING MACHINE WITH AUTOMATIC REVERSE

In the department of New Machinery and Tools for May, 1908, and November, 1909, we illustrated and described the 20- and 24-inch all-geared drills built by the Barnes Drill Co., 602 S. Main St., Rockford, Ill. This company has now brought out a new design, which, while of the same general construction as those previously described, contains some noteworthy improvements. By referring to the accompanying illustration, it will be seen that this drill, which is of the automatic reversing type, has a single pulley for driving and reversing. A reverse speed of 1¾ to 1 is obtained by means of friction clutch gears which are mounted on the driving end of the machine instead of being on the spindle. The automatic reversing mechanism is a very desirable feature, particularly for depth tapping. It can be set so that the instant the tap reaches the required depth, the spindle will automatically reverse and back the tap out at practically twice the speed at which it entered. This mechanism can also be set so as to trip automatically (or by hand) and stop the spindle instantly without reversing its movement. The spindle may be reversed or stopped at any time by a small trip lever which is conveniently located. This machine has four direct, geared speeds and four back-geared speeds, making eight changes of geared speeds available.



Barnes 20-inch All-geared Tapping Machine with Automatic Reverse

This type is built in 20- and 24-inch sizes, and the makers claim that these machines are the strongest and most powerful upright drills of their swing. The 20-inch machine drives a 1¼-inch U. S. standard tap, running at 125 revolutions per minute into cast iron, without using the back-gears. When the back-gears are thrown in, a 1½-inch U. S. standard tap may be driven into cast iron at a speed of 50 revolutions per minute, while the 24-inch size will drive a tap up to 2 inches in diameter. With the positive power feeds added to these machines, they can be used advantageously for both drilling and tapping.

LODGE & SHIPLEY CRANKSHAFT LATHE

In the department of New Machinery and Tools of the June, 1909, number of MACHINERY, we illustrated and described a lathe manufactured by the Lodge & Shipley Machine Tool Co., Cincinnati, for turning the ends of automobile crankshafts of 2½ inches throw. Recently this firm has built a lathe for

turning much larger crankshafts, a general view of which is shown in Fig. 1. This machine is a standard 36-inch patent head lathe raised in the sand to swing 42 inches over the shear. The special attachment for holding a shaft while it is being turned, is illustrated in Figs. 2 and 3. This attachment can be easily adjusted to bring the crankpin center into alignment with the axis of the lathe spindle, and it also affords a powerful drive and rigidly supports the crank so that there is practically no springing action when taking a cut.

A swiveling chuck *A* attached to the faceplate, carries one end of the crankshaft by securely gripping it in a bearing having a hinged cap. The base upon which the chuck swivels, has a tongue which fits a planed slot passing through the center of the faceplate. This chuck can be placed with its center coincident with the center line of the lathe to turn shaft bearings, or it can be set eccentrically to any desired amount within its range, for turning crankpins. The swiveling base allows the attachment to be adjusted for shafts having pins located at different angles. A steel strip *B* bolted in the slot at one side of the chuck-plate, locates the chuck at just the proper distance off center to give the correct throw for the crankpin to be turned. The weights shown attached to the faceplate opposite the chuck are for counterbalancing both chuck and crankshaft.

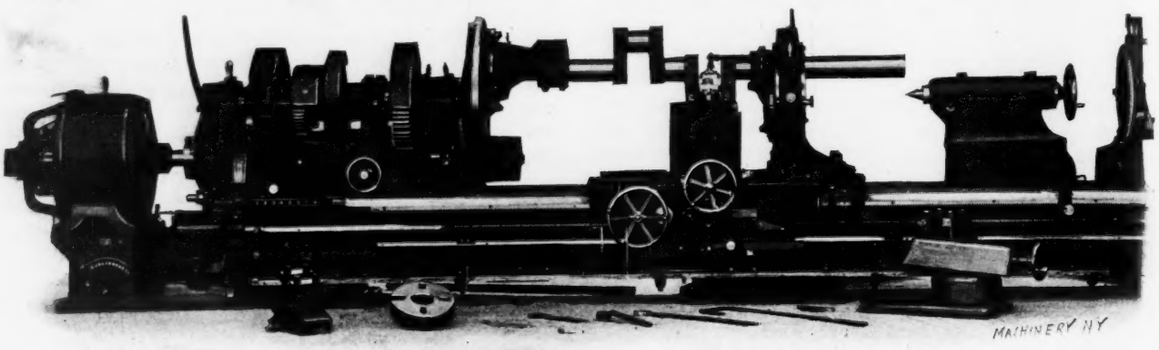


Fig. 1. Large Crankshaft Lathe built by the Lodge & Shipley Machine Tool Co.

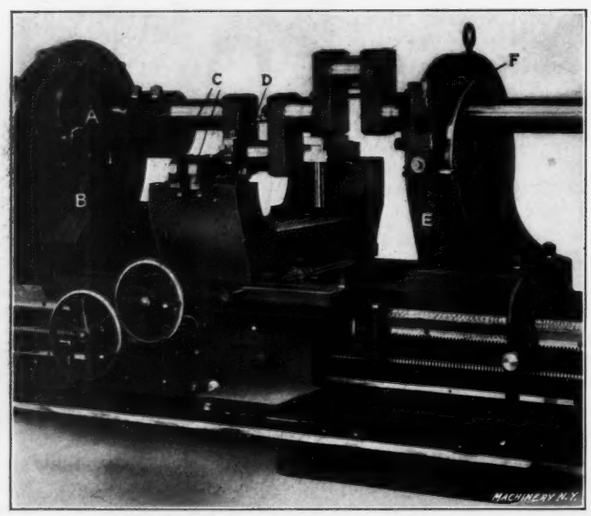


Fig. 2. View showing the Crankshaft Turning Attachments

When turning the pins, the outer support *E* holds the tail end of the crankshaft. This outer support is a carrier chuck, but not a driving head, as the drive for the crankshaft is from the faceplate end only. The shaft is held at the proper distance off center by being gripped in the hinged bearing *M* which is attached to the central rotating chuck. There is an annular bearing *F* in the outer support, so that the chuck carrying the eccentrically-located shaft is free to revolve. Thus the clamping bearings of both the swiveling chuck and the outer support, always remain in line as the shaft revolves. This outer support also serves as a steady-rest, by gripping the shaft close to one of the crank webs.

Locking pins *H* and *N* bring the two clamping bearings into exact alignment with each other before the hinged caps are finally tightened to grip the crankshaft. The faceplate locking pin is carried in a bracket attached to the inner ways of the bed. A star knob on the front of the bracket furnishes convenient means for sliding the pin into or out of its seat in the faceplate. The locking pin in the outer support is similarly operated. Before placing the crankshaft in the lathe, the two locking pins are slipped into their seats, which exactly aligns both chucks, so that the shaft can be placed in them and gripped without danger of springing. The locking pins are then withdrawn, leaving the chucks and shaft free to revolve.

Connected front and rear tool-rests are used, both rests being cast in one piece with the long cross-slide that is mounted upon the bridge of the carriage. This slide has power feed as well as hand movement. An upright post gives a firm support to each tool almost out to the cutting point, and prevents excessive overhang. The front block carries three tools. Two of these tools *C* are for facing the cheeks of the shaft and are carried in a hinged holder so that they can be thrown back when not in use; the third tool *D* turns the cylindrical portion of the pin. The rear tool-rest has a holder *K* containing two cutting tools spaced just the proper distance apart to fillet the ends of the pin, and thus determine the length of the portion which is to be turned.

Since the special fixtures are needed only for turning the pins, our description has covered that work only. The turning of the bearings is a separate and previous operation, being straight turning between centers with the outer support removed, the swiveling chuck on the center of the faceplate and the tailstock center supporting the other end of the crankshaft.

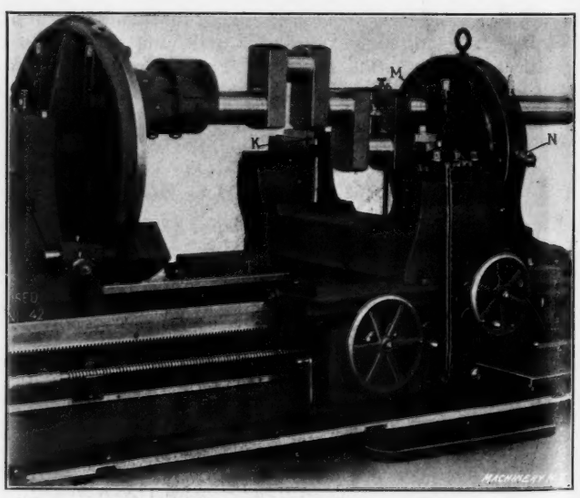


Fig. 3. Another View of the Turning Attachments

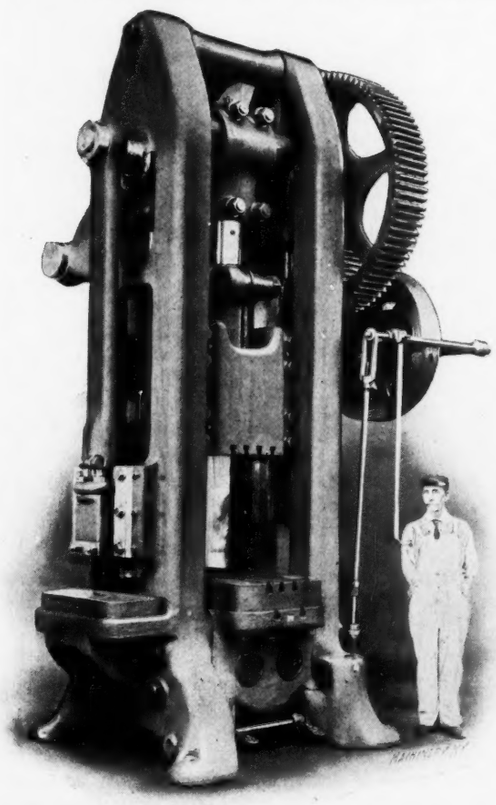
Multiple stops for length and cross feeds are included in the equipment, and greatly increase the output. These stops have already been described in detail in our description of the smaller crankshaft lathe. We will therefore merely mention here that the longitudinal stops positively determine the correct location of the carriage for all fillets and shoulders, and

that the diameter stops locate the cross-slide to give proper finished diameters when either the front or the rear tools are cutting.

Even when the lathe is not used for turning crankshafts, it will be found a valuable manufacturing tool. The equipment also includes the regular engine lathe parts, such as a small faceplate, compound rest, full swing rest, and wrenches. The crankshaft attachment can be quickly removed from the lathe, and the compound rest substituted for the connected front and rear tool-blocks, leaving the machine in shape for handling the full range of work suitable for an engine lathe.

LARGE FERRACUTE TRIMMING PRESS

The Ferracute Machine Co., of Bridgeton, N. J., has recently built from designs of its president, Mr. Oberlin Smith, several heavy trimming presses for use in a prominent locomotive works. Some of these presses are intended for pressures of 300 tons and others for 200 tons, the illustration showing one of the 300-ton presses. This machine contains a side punch for similar work of a lighter character, thus adding considerably to the capacity of the press. The distance between the columns is 32 inches and the bed measures 30 inches across and 50 inches from front to back. As the engraving shows, the bed, bolster, and ram contain T-slots for die-clamps. The bed of the side punch is 15 by 30 inches. The stroke of the

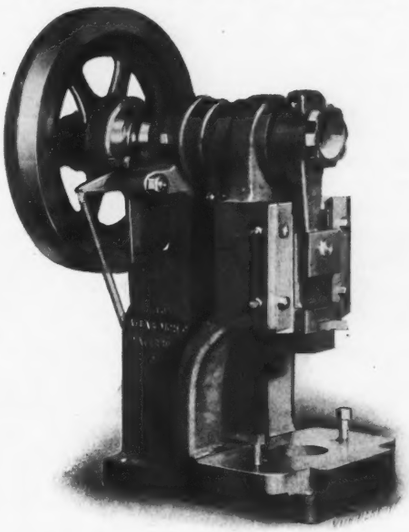


Ferracute Trimming Press of 300-ton Capacity

main press is 12 inches with a 10-inch adjustment, and the side punch has a stroke of 3 inches. The height from the bed to the ram with the latter at the top of its stroke and adjustment, is 34 inches. The drive of the machine is double-geared, the power being transmitted from the flywheel shaft by a pinion and gear to an intermediate shaft at the rear which, in turn, through a second pinion, drives the large gear which is mounted on the main shaft. This arrangement gives a gearing ratio of 50 to 1. The main shaft is a steel forging having a diameter of 9 inches at the journals and 11 inches at the crank. The flywheel is 40 inches in diameter, has a 7-inch face, and weighs 1100 pounds. This press is equipped with a friction clutch which enables the operator to start or stop it at any part of the stroke. The machine occupies a floor space 10 feet by 7 feet 6 inches. Its height is 14 feet, and the weight, approximately 68,500 pounds.

ATLAS BENCH POWER-PRESS

The small bench power-press illustrated herewith has been designed by the Atlas Machine Co., Waterbury, Conn., to meet the demand for a medium weight machine of this type. One of the interesting features of this press is the new one-revolution positive stop clutch which is simple in construction and at

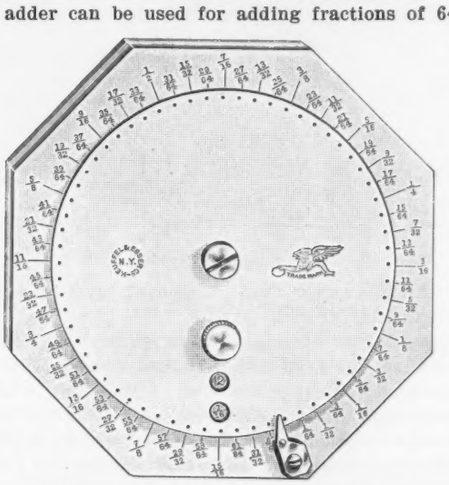


Bench Power Press made by the Atlas Machine Co.

the same time sure in its operation. This clutch, which is operated in the usual manner with a foot-treadle, is released by the striking of a cam point against a knuckle piece, that in its movement slightly raises the pull-down latch and at the same time pushes it off the clutch lever, thus releasing the lever in ample time to engage the driving key which, in turn, pulls out and stops against a positive projection, thus making it impossible for the press to repeat. To arrange the machine for continuous running, it is only necessary to loosen a nut and drop the knuckle piece against which the cam point strikes. In this clutch there are few parts to wear or to become broken, and all the parts are operated by a single spring which is of considerable length, as the engraving indicates. The stroke of this press is 1½ and 2 inches. The height from the bed to the gate (when down) is 7¼ inches, and the die-bed has a surface of 13 by 8 inches. The weight of the press complete is 375 pounds.

KEUFFEL & ESSER FRACTION ADDER

A very simple but practical instrument, by means of which fractions may be quickly added, is illustrated herewith. This fraction adder can be used for adding fractions of 64ths, or



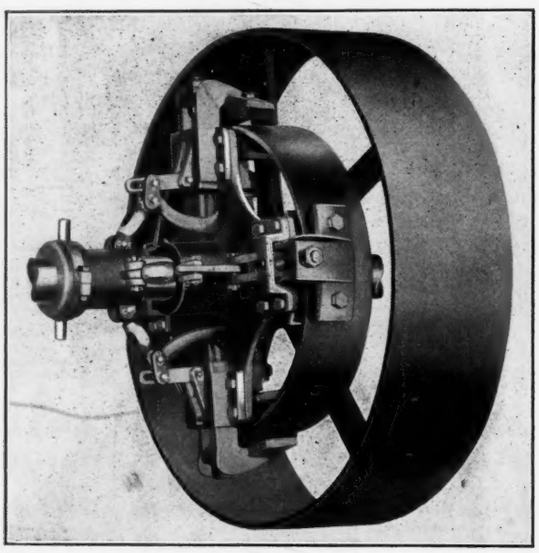
Instrument which automatically adds Fractions

multiples thereof, up to 16 integers. A white xylonite disk which revolves on an octagonal polished wood base covered with white xylonite, has near its circumference sixty-four indentations which correspond in position to the fractional grad-

uations marked on the base. At the lower edge of the base a nickel-plated stop is attached which projects over the disk as shown. If a pointed instrument or pencil point is placed in the small indentation at the circumference of the disk opposite the fraction to be added and the disk is rotated until arrested by the contact of the stop with the pointer, the fraction at which the pointer was originally set will be shown on the counter, providing the latter was set to zero by means of the milled head screw shown, before performing this operation. To add to this fraction any number of fractions, it is simply necessary to place the pointer in the indentation opposite each fraction to be added, and rotate the disk each time until the pointer comes against the stop. The counter will show each successive total through the two windows in the disk, one of these openings giving the integer and the other the fraction. The usefulness of this device will be at once appreciated by those constantly engaged in the checking of drawings or in other computations involving the addition of fractional parts. This instrument is the product of the Keuffel & Esser Co., 127 Fulton St., New York.

LEHIGH RIM FRICTION CLUTCH

A clutch that is especially adapted to high speeds and is suitable for motor-drives or wherever a quick-acting and powerful clutch is required, is illustrated herewith. This clutch, which is made by the Lehigh Clutch Co., Catasauqua, Pa., is of the opposite jaw type, that is, there are two jaws on each arm, making four sets in all, which grip the friction ring both on the outside and inside as the engraving indicates. In operation the outer jaw is drawn toward the center of the clutch and the inner one is forced away from it, the friction ring being gripped between them. A separate positive-acting lever and link are employed to operate each jaw, and connection is made with the spool by special turnbuckles. When the shoes wear, these turnbuckles provide convenient means for adjustment. No springs are used to release the clutch, but the jaws are moved from the rim by positive-acting levers, which are so arranged that the clutch may be engaged or disengaged, it is



Lehigh Rim Friction Clutch

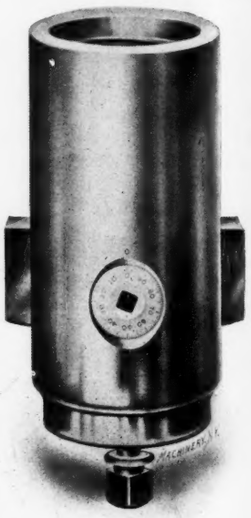
stated, with less power than is required for any other clutch of equal capacity.

The construction of this clutch is such that either the inside or the outside jaws may be adjusted independently without disturbing the other member of the pair. The wooden shoes or friction blocks which bear against the rim may be renewed, when necessary, in a very short time, as all that is required is to move the jaws away from the friction ring, loosen the two bolts holding the wooden shoe in place, and slide it along the friction ring until it clears the jaws.

The spider, the spool and the jaws are made of a special mixture of cast iron, while the operating levers and those parts which are subjected to severe strains are made of malleable iron. Each piece of the clutch is finished in jigs, thus making them interchangeable and easy to replace when necessary. This type of clutch is manufactured in all sizes from 12 to 84 inches in diameter and for transmitting from 4 to 1350 horsepower at 100 revolutions per minute.

THE DAVIS EXPANSION BORING TOOL

The Davis Expansion Boring Tool Co., Broadway and Bremen Ave., St. Louis, Mo., has developed a number of improved boring tools, one type of which we illustrate herewith. The particular tool shown, which is known as the style A head, is intended to be screwed onto the end of an ordinary arbor or shank, and it is suitable for use in either the lathe, boring mill, or drill press. One of the points of superiority of this tool over the ordinary cutter used, lies in the ease and quickness with which it can be adjusted to compensate for wear. This feature is, of course, of considerable value when boring to a given size, owing to the fact that it enables the use of higher speeds than would be considered practical with the ordinary non-adjustable tool, as the increased wear of the cutter incident to the higher speeds can be quickly taken up. This tool is adjusted to any size within its range by simply inserting a key wrench in the squared hole of the screw. This screw, which is graduated to give micrometer adjustment, operates a double-expanding tool-steel wedge that comes in contact with the cutters and forces them outward. As the expanding wedge is hardened and accurately ground to obtain a good contact with the cutters, the latter, as far as rigidity is concerned, are practically as one piece. The adjustable feature of this tool is also valuable in connection with grinding the cutters, as grinding to an exact size is immaterial, owing to the possibility of adjustment. Both cutters should, of course, be ground square, to the same length, and have proper clearance for the cutting edges, the same as with the solid type. These tools are made in all styles and in twenty-one sizes to meet the requirements and conditions of every shop.



Davis Expansion Boring Tool

ROCKFORD 14-INCH ENGINE LATHE

The engine lathe shown in the accompanying engraving is of a design that is well adapted to the work of the tool-room, as well as to general manufacturing purposes. This machine is the latest addition to the line of tools manufactured by the Rockford Lathe & Drill Co., Rockford, Ill.

The headstock of this machine is heavily constructed and it is fitted with a 5-step cone with wide face, thus making possible a powerful drive. The bearings are large and they are fitted with the highest grade of babbitt metal obtainable. The spindle has thrust bearings which are also of large proportions and the thrust can easily be taken up or adjusted in a few minutes. The tailstock is of the offset type so that the compound rest can be swung around 90 degrees or parallel with the bed. An eccentric lever is used for clamping the tailstock so that it is possible to quickly adjust it without the use of a wrench. In addition there is an auxiliary locking arrangement for securely fastening it to the bed when doing heavy work.

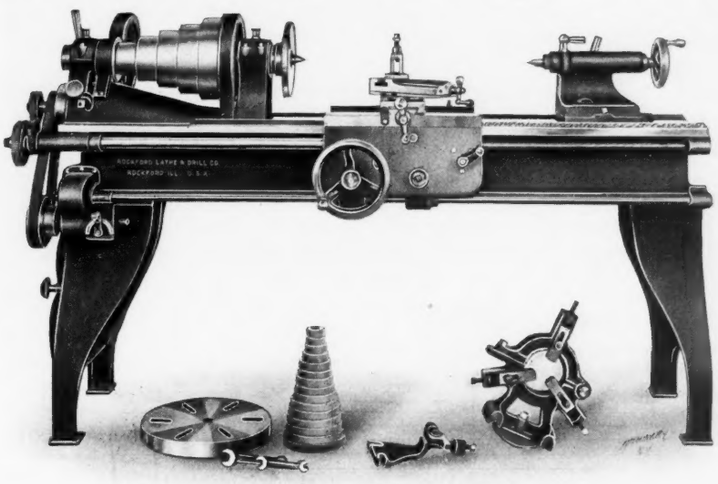
One of the striking features of this machine is the addition of a third bearing in the center of the bed which forms a rigid support for the carriage and insures a steady cut and the elimination of all chatter. This support is provided with a taper block which makes it possible to compensate for wear. The carriage is of a heavy pattern and the carriage-slide is dust-proof, as well as chip-proof, protection being afforded by means of a cover.

All shafts in the apron have double bearings so that the

strains are well taken care of, and the worm runs in oil. The cross-slide has a specially designed locking nut which makes it possible to quickly lock the compound rest or tool-slide at any point along the screw. This is a desirable feature in connection with the use of a taper attachment, as it is only necessary to loosen this nut, and there is no danger of dirt getting down into the screw.

The feed is by belt drive to a gear-box by means of which three changes, controlled instantly by a lever, are obtained. As two-step cones are provided, this number is doubled, making six feeds in all. The width of the feed belt is 1¼ inch, which, combined with the ratio of gearing in the box, gives a powerful drive.

The bed is of the heavy box pattern and it is so arranged that a taper attachment can be applied at any time. The legs supporting the headstock end of the bed contain a cabinet which has shelves enough to accommodate all the change gears, thus keeping them free from dust and dirt. The central hole of the faceplate furnished with this machine is made just large enough to admit the center thus making it possible to use this extra surface when boring small jigs and similar work, which could not be held on the conventional faceplate owing to the diameter of the central hole.



Fourteen-inch Engine Lathe built by the Rockford Lathe and Drill Co.

This lathe is particularly adapted to tool-room work, as it has a thread-cutting capacity ranging from 1 to 92 threads per inch. So far as we know, this is the largest range of threads that can be cut on any lathe. This machine swings 16 inches over the bed and 9¼ inches over the carriage. The diameter and lengths of the front and rear headstock bearings are, respectively, 2½ by 4 and 2⅛ by 3 inches. The length of the bed is 6 feet 6 inches and the maximum distance between the centers, 36 inches. The net weight of the machine is 1900 pounds.

SCOTT BRAZING FURNACE

The brazing furnace shown in the accompanying engraving is a recent design brought out by C. U. Scott, Davenport, Iowa. This furnace may be operated by city gas or gasoline, and it is provided with two burners which are mounted on standards located at each side of the table. The blocks by which the burners are attached to the standards may be adjusted (by loosening a handle nut) in either a vertical or horizontal plane or vertically on the standards, so that the flame from the burners can be brought to bear on any part of the top of the furnace. Connection with the air and gas pipes is made by flexible hose, and valves at the side of the table provide convenient means for proportioning the mixture admitted to the burners. As the engraving shows, the top of the furnace is supported on well-braced legs, and it has a rectangular opening in the center through which long parts can extend. Two important features claimed for this furnace are, that the heat can be taken without scaling work and the burners will not blow out while in operation. As soon as the burners are lighted, a temperature of 1872 degrees is available.

HOEFER CONNECTING-ROD DRILLING AND FACING MACHINE

The manufacturers of automobile engines have realized the necessity of performing the various operations on the motors with machines especially adapted to work of this class. Heretofore, considerable motor work has been done on standard machines which required many changes, in order to adapt them to certain operations, which of course affected the output. One of the expensive operations in the manufacture of automobile engines is the connecting-rod, which requires accuracy and perfect alignment, both in drilling the holes and facing the ends. After studying the problem, the Hoefer Mfg. Co., 120 Jackson St., Freeport, Ill., has designed a special machine for this purpose, which drills and faces accurately both ends of the engine connecting-rod without the necessity of changing the rod in the jig, or changing the tools or drills.

Scott Brazing Furnace with Two Adjustable Burners

The principle of the machine, front and rear views of which are shown in Figs. 1 and 2, is extremely simple and its operation can be readily mastered by comparatively inexperienced men. The attachment and operating devices are so arranged that it is almost impossible for the operator to produce defective work. The machine consists principally of two heads, which are adjustable and gibbed to a solid bed. One of these heads carries the drilling spindles for both the large and the small ends of the connecting-rod, and the other head has two spindles in which are placed the facing tools for the ends of the rods. The connecting-rods are placed in a trunnion jig which has hardened steel jaws operated by a quick-releasing screw. The jaws clamp the rod firmly during the operations of both drilling and facing, as but one setting of the rod in the jig is necessary to complete it, which gives the best possible results.

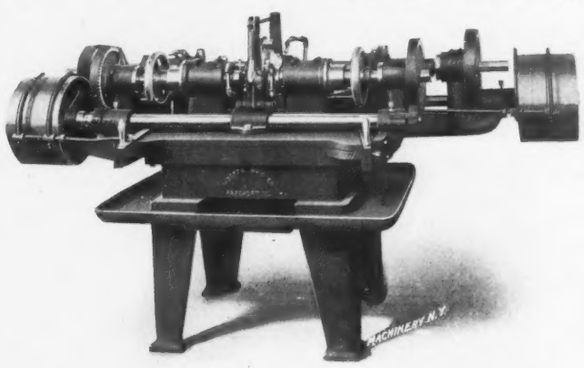


Fig. 1. Front View of Hoefer Connecting-rod Drilling and Facing Machine

After the rod has been set, an eccentric lever on the two

projecting arms is locked, thus giving additional support to the rod for high-speed drilling. The small end of the connecting-rod is drilled first by throwing in a power feed lever. While the drill is removing the stock, the operator, by means of two handwheels shown in Fig. 1, faces the sides of the large end, and as the cutters face concentric with the holes, a very

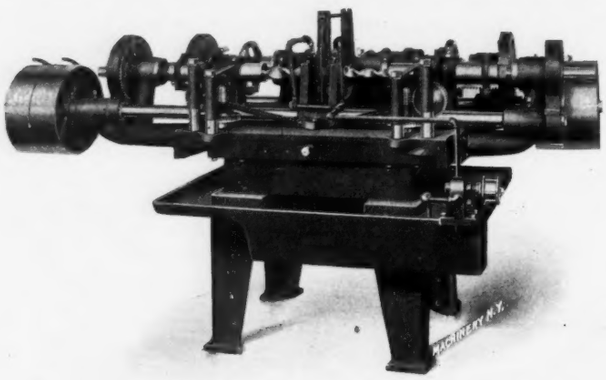


Fig. 2. Rear View of Connecting-rod Drilling and Facing Machine

good finish is secured. When these operations are completed, the eccentric lever is opened and the trunnion jig is swung 180 degrees against an adjustable positive stop. After clamping the ends of the rod again by means of the eccentric lever, the power feed of the large drill spindle is thrown in and the large end is drilled while the operator faces the small end. As the spindles are in perfect alignment with the trunnion jig which carries the connecting-rod, absolute accuracy is assured. In each end of the trunnion is placed an adjustable positive stop (steel hardened) for the facing tools, and each end of the rod, as it is swung from one position to another, carries with it its own stops so that when once set, all dimensions are duplicated.

The spindles are made of a crucible steel, carefully ground and run in bronze bushed bearings. They are driven through gearing by wide-faced pulleys which rotate at a high speed, thus insuring ample power. The two drilling spindles are driven by one driving shaft, but the gearing is proportioned to give the proper speeds for the large and the small drills. The two heads carrying the drill and facing spindles are gibbed to a heavy bed and are adjustable for connecting-rods varying in length from 10 to 14 inches.

With ordinary connecting-rods, it requires about five minutes to drill and face both ends; this time includes picking up the rod, fastening it in the trunnion jig, and taking it out of the jig. Even better time than this has been made on a day's run.

As there is but slight variation in the holes of ordinary connecting-rods, the machine was designed for but one speed. The feed also has but one speed, so in neither case can the operator change the speed or feed.

ELECTRICALLY CONTROLLED REVERSING DRIVE FOR POND PLANERS

An electrically controlled reversing mechanism for direct motor-driven planers, characterized by its remarkable simplicity, has recently been applied by the Pond Works of the Niles-Bement-Pond Co., Plainfield, N. J., to the regular line of heavy planers brought out by this company. Some of the advantages

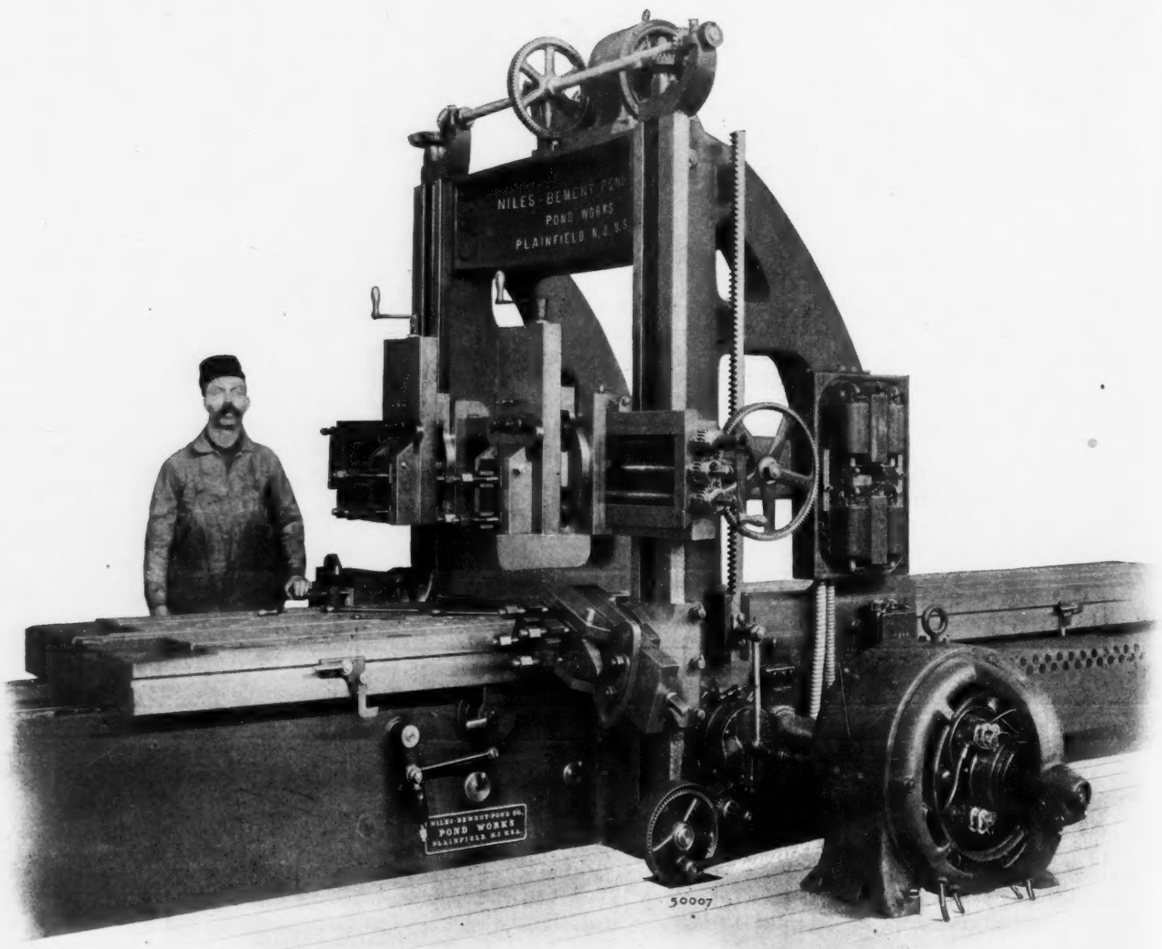


Fig. 1. Pond Planer with Electrically Controlled Reversing Mechanism

of this reversing drive are that the overload on the motor at the time of reversal is reduced to a minimum; that it is possible to obtain very short strokes of the platen without any perceptible shock, and without injury or abnormal wear to the mechanism; and that the platen motion becomes practically positive, the platen stopping at the end of every stroke within a limit of variation of less than one-eighth inch.

A planer provided with direct motor-drive and reversing mechanism of this type is shown in Fig. 1. The whole driving and reversing mechanism consists of a motor mounted directly on the pinion shaft, a controller mounted on a marble panel on the side of the planer housing, as shown, and a pilot switch placed in the same position on the planer bed as the hand lever control or rocker lever of the ordinary belt-driven machine. This pilot switch is tipped by adjustable dogs on the side of the platen in the same way as is the ordinary rocker lever, and by its movement it electrically operates the controller. It is entirely enclosed and is but six inches in outside diameter.

The controllers are made in two sizes, according to the size of motor for which they are to be used. The controller for motors from 7½ to 30 horsepower is provided with three magnets, while the controller for motors of 35 horsepower and up consists of four magnets or solenoids, on the plungers of which are mounted the electrical contacts. This latter type is the one shown in Fig. 1. The only parts susceptible to wear and replacement in the mechanism are the contacts, but these are all simple in shape, being made of sheet copper or bar stock such as would be found in any average shop. The replacement can be made by any mechanic.

On the controller are mounted two index scales or dials, one controlling the range of cutting speeds and the other the return speeds. These scales will be seen in Fig. 1, one on each side of the magnets. Each scale is provided with thirteen graduations or divisions by means of which the same number of different motor speeds are obtainable by simply sliding a knob on the scale. The cutting speeds obtainable on the standard type of planers vary from 25 to 40 feet, and the return speeds from 60 to 100 feet; but these speeds can, of course, be changed to suit individual requirements. The cutting and return speeds are entirely independent of each other, so that it is, for example, possible to use the slowest cutting speed and the highest return speed, or *vice versa* should this for any reason be deemed desirable. The reversible electric motor used is built by special specifications and it is shunt wound with a speed range of 4 to 1, the revolutions per minute varying from about 250 to 1000.

As will be seen from the illustration Fig. 1, the pilot switch is provided with a handle so that it may be operated by hand instead of by the reversing dogs, thus giving the operator immediate control of the machine. By a slight movement of the switch it may be placed in a neutral position which will immediately stop the platen. A valuable feature of the planer is that, owing to this direct hand control, it is possible for the operator to control the speed at any time during the cutting or return strokes. For example, in working castings with hard spots, thin walls, etc., or working a line of castings mounted on the platen, when one or more castings are harder than the others, the operator would set his index for the cutting speed most suitable for the average of the softer castings, and when the tool is about to enter the harder metal or the thin walls, he can, by simply moving the pilot switch by hand, obtain a reduction of cutting speed which will be maintained until the pilot switch is returned to its former position. Thus the platen is under the absolute control of the operator, even when in motion, and it is possible to stop the table within a limit of ⅛ inch by throwing the pilot switch to the neutral or "off" position.

On account of the controller's automatic action it is impossible to reverse the motor's direction of rotation until its speed is very low. This feature not only reduces the power required for reversal by nearly 100 per cent at the instant the direction of motion changes, but it also saves the feed line from any voltage surge or pumping action. At the moment of reversal the motor acts as a generator and tends to stop itself. The length of time of this action is automatically taken care of by the ingenious design of the controller. The variable speed of the motor is dependent entirely on shunt field regulation, and no armature resistance is used. Another important feature is that at the instant of starting, the motor has full field strength, giving it the maximum torque at a time when it is most required.

In Figs. 2 and 3 are shown two charts giving the load curves of a planer operated by this reversing drive, and showing that even at the time of reversal the motor is not subjected to excessive load, and hence in no way to excessive heating; it can, therefore, stand up to the requirements of modern service for any length of time.

The most noteworthy of the advantages of this drive may be briefly summarized as follows: The elimination of any frictional drive mechanism, such as is introduced by belts, friction clutches, etc., tends to give a more positive stroke and eliminates the shocks incident to reversal. There are no replacements necessary on account of the wear of friction surfaces, the only wearing parts being the contacts, as mentioned,

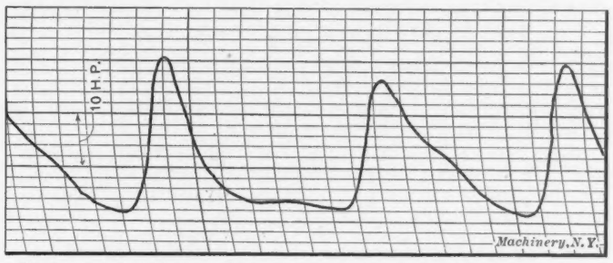


Fig. 2. Curves for Power Consumption, 84-inch Pond Planer with 35-horsepower Motor, Stroke of Table 71/2 inches, Cutting Speed 30 feet, Return Speed 65 feet

which may be easily and quickly replaced. The speed range is greater than that possible with any other drive, and cutting and return speeds are independent of each other. The shock at the time of reversal is almost entirely eliminated, due to the elimination of the rapidly revolving belt driving pulleys. It has been ascertained by experiments that 85 per cent of the momentum of a planer at the time of reversal is due to the rapidly revolving driving pulleys. The possibility of obtaining a short stroke—from 3 to 4½ inches on 36- to 96-inch planers—is also a feature well worth mentioning; and the ease of operation, the platen being at all times under the absolute control of the operator; the possibility of changing the cutting speed during any part of the stroke; and the elimination of a great number of driving members liable to wear and damage are features of high importance. The small space occupied by the controller is also an advantage. The con-

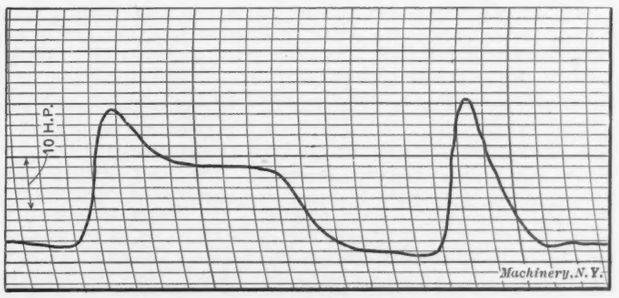


Fig. 3. Curves for Power Consumption, 84-inch Pond Planer, with 35-horsepower Motor, Stroke of Table 12 inches, Cutting Speed 30 feet, Return Speed 110 feet

troller used for motors up to 30 horsepower occupies a space of only 17½ by 19¼ inches, and is 4½ inches thick. Considerable economy is also obtained by the method of absorbing the inertia of the motor, due to the fact that at the instant of reversal the motor acts as a generator and produces the power which stops it.

The builders are prepared to equip their full regular line of planers with this drive, and will also attach it to their belt-driven type of planers in which case the motor is connected directly to the driving shafts on which the belt pulleys ordinarily are mounted.

* * *

The following is from a paper by J. B. Doan of the American Tool Works Company on the tariff, read at the Rochester meeting of the National Machine Tool Builders' Association: "As an example of the varying import duties upon machine tools when shipped into some of the leading countries, I quote the following approximate figures, applying to the shipment of a 14-inch or 16-inch lathe, weighing approximately 1,800 pounds: Into Germany, $15.61; France, $38.02; Denmark, $24.10; Austria-Hungary, $40; Italy, $14.28; Russia, $107.84."

NEW MACHINERY AND TOOLS NOTES

Engine Lathe: South Bend Machine Tool Co., South Bend, Ind. Lathe that may be operated by the foot or with power as desired. It swings 13 inches over the bed and has a maximum distance of 33 inches between the centers.

Tumbling Barrel: E. C. Bliss Mfg. Co., 91 Sabin St., Providence, R. I. Small double tumbler designed for bench use. The finishing and burnishing is accomplished by the use of steel balls which have proved efficient for this work.

Oilless Roller Bearing: Troy Roller Bearing Co., Troy, N. Y. Bearing that is designed to run without oil, a small amount of dry graphite being the only lubricant used. Bearings of this type are made for practically all purposes.

Pipe Die Stock: Borden Co., Warren, O. Die stock equipped with narrow dies which recede to form the pipe taper. The dies may be adjusted by simply shifting a cam, so that pipe from 1 to 2 inches in diameter may be threaded. The dies cut easily, and it is stated that a 2-inch pipe may be threaded by one man without difficulty.

Shop Truck: Gannett Electrical Co., 55 Pine St., Providence, R. I. Small, heavily-constructed two-wheeled truck for moving heavy machinery or parts. By connecting two of these trucks in line with a neavy timber, a narrow truck of any length can be made, and by attaching two such trucks with cross-pieces, the width can be extended as required. Each of these trucks weighs about 30 pounds.

Lathe Tool-holder: Kearney Foundry, Machine & Automobile Co., Kearney, Neb. Tool-holder in which the blade is clamped between two wedge-shaped washers by a slotted bolt through which the blade passes. This method of clamping and holding the tool permits adjusting it vertically or swinging it to the right or left. It is also possible to tilt a thread-tool to the angle of either a left- or right-hand thread.

Core Machine: Falls Rivet & Machine Co., Cuyahoga Falls, O. Vertical jar-ramming core machine, which forms the core in a vertical shell or core-box, that is given a jarring motion by two ratchets which alternately lift and drop the core-box in order to compact the sand. For making ordinary straight cores, the core tube itself may be used, but for irregular work, special dies or core-boxes are inserted in this vertical tube.

Low Knife Bar Shear: Thomas Carlin's Sons Co., Henry W. Oliver Building, Pittsburg, Pa. A shear designed for cutting muck bars or other material within its capacity. It will sever soft steel stock up to 1¾ inch square. As the shear arm is connected directly with the crankshaft by a pitman, it has a speed of from 60 to 80 working strokes per minute, thus making it possible to handle large quantities of material in a given time.

"Changeezy" I-Beam Trolley: New Jersey Foundry & Machine Co., 90 West St., New York City. Trolley that is so constructed that it may be converted from a plain to a geared one or *vice versa*, thus making it possible to rack the trolley along the track when handling heavy loads or to pull it along at comparatively high speed when light, by disengaging the gears. This change is made by the hand-chain, which is also used to move the trolley by the rack and pinion.

Right-angle Drilling Attachment: Lowndes & Butler, Norristown, Pa. Compact attachment intended for drilling in places where lack of room precludes the use of an ordinary power drill. The driving shank has a Morse taper and is connected with the drill socket by hardened steel spiral gears provided with ball thrust bearings. This attachment is made in four sizes with drill capacities ranging from 9/16 to 2 inches, and corresponding weight variations of from 2¼ to 10 pounds.

Pneumatic Chuck: Bashlin Tool Works, Grove City, Pa. Pneumatically-operated chuck for small lathes that is intended for the rapid handling of castings of irregular shapes. These chucks are made with jaws of two styles, the alligator and the four-hinged, either of which may be attached to the master collet used. The four-hinged chuck is intended for round or hexagonal work, etc., while the alligator jaws are for holding irregular parts, such as valve bodies, air and gas cocks, and similar pieces.

Friction Clutch: F. C. Sanford Mfg. Co., Bridgeport, Conn. Clutch that transmits power by friction alone until the speed and resulting centrifugal force is great enough to swing out pivoted locking dogs, which engage with pins and form a positive drive. The design is such that the work of the friction surface is confined to starting and accelerating to normal speed, thus lengthening the life of the clutch. The locking dogs and the pins with which they engage, are of hardened nickel steel and the clutch itself is bronze-bushed.

Double-Head Traverse Drill: National Machine Co., Hartford, Conn. Two-spindle drill which differs from previous designs in having a hand feed instead of an automatic feed, both spindles being fed simultaneously by a pilot wheel at the front of the machine. The heads are adjustable along the bed giving a maximum distance of 20 inches between the spindles. The spindles have a travel of 5⅜ inches, and the distance from the spindle centers to the bed is 7 inches. The machine will drill holes up to 9/16 inch in diameter.

Pipe Wrench: Brosnihan Wrench Co., 31 Hermon St., Worcester, Mass. Pipe wrench designed along the lines of an ordinary monkey wrench and equipped with hardened and tempered tool steel jaw faces which are serrated for gripping pipe or other round parts. The face of the sliding jaw is wedge shaped and it is free to slide on a correspondingly inclined surface on the jaw so that work is gripped tightly by the wedge action when pressure is applied to the handle. Extra jaw faces can be furnished when desired. These wrenches are made in four sizes, ranging from 8 to 18 inches.

Special Drilling Machine: Buckeye Machine Co., 2617 East 76 St., Cleveland, O. Special machine for drilling cross holes in bolts, etc., for cotter pins or other retaining devices. The machine has five drilling spindles and the work is clamped by quickly operated levers so that the holes are drilled centrally and the correct distance from the bolt ends. Each spindle with its drill is automatically fed by cams which are mounted on a horizontal shaft extending across the machine. The drive is through a single pulley mounted on the central spindle which transmits the movement to the remaining spindles by spur gears.

Mono-rail Trolley Hoist: Heyl & Patterson, Inc., Pittsburg, Pa. Mono-rail trolley hoist, the frame of which is hung from two cast-steel trucks by steel straps which rest on ball bearings. With this construction, the trucks are independent of each other so that they will operate on comparatively small curves. Each truck has four 10-inch cast-steel wheels, which are set at such an angle as to be perpendicular to the slope of the I-beam flange on which they run, thus reducing the wear on both the flange and wheels. This trolley is provided with an operator's cab and is driven by an 11 horsepower Westinghouse motor.

Auxiliary Planing Head: Cincinnati Planer Co., Cincinnati, O. An auxiliary floor planing head intended to handle work usually done on the open side planer. It consists of a column with a swiveling head which has a vertical travel above the planer table of 42 inches. The face of the column is pivoted in the center so that by swinging it around, the planing head may be used on either side of the planer. Power feed is taken from the double combination friction on the planer itself, connection being made to the feeding mechanism of the column by a suitable rod. The feeds are controlled by a small lever at the top of the tool-head, and the amount of feed may be varied by means of a slotted crank.

Improvements in Surface Grinder: Walker Grinder Co., Worcester, Mass. The Walker "single-stroke" rotary surface grinder, which was illustrated and described in the February, 1910, number of MACHINERY, has recently been equipped with a number of improvements. The spindle is now driven with an independent belt drive, the belt transmitting the power direct from the countershaft at the rear to the spindle by a quarter-turn belt, thus giving a more powerful drive than formerly obtained. The quarter-turn belt in the column which transmits power from the countershaft to the table speed-change mechanism, has been provided with an improved take-up device for varying the belt tension. This design is also equipped with a new belt shifter, which may be easily operated and which is conveniently located.

Heavily Designed Radial Drills: Mueller Machine Tool Co., Cincinnati, O. Heavily designed 4- and 4½-foot radial drills brought out to meet the requirements of modern practice. The column is heavily constructed, and the arm is of hollow rectangular section and has been increased considerably in weight. The arm can be locked to the column by one handle and it can be lowered at twice the elevating speed. The back-gears are located in the head and they may be engaged or disengaged without shock and while the machine is in motion, by a conveniently located lever. A tapping mechanism is provided, and the spindle is equipped with a depth gage and automatic stop. A speed box of the geared friction type gives twelve changes of speed, which is doubled by the back-gears, making twenty-four speeds in all available for the spindle. By means of a combination positive and friction feed, eight changes to each change of spindle speed may be obtained without stopping the machine.

Electric Controllers: General Electric Co., Schenectady, N. Y. Controllers for use on electrically-driven machine tools and wherever the starting service is frequent or of a severe nature. They are of the drum type and have embodied in their construction a number of special features to adapt them to the conditions of modern practice. Among these may be mentioned substantial removable barriers between the fingers wherever required; magnetic blow-outs for all equipments for 500-volt service or for large currents at lower voltages; special screws to hold the segments with heads slightly countersunk below the surface so as to prevent their wearing with the segments, and tapered at such an angle as to prevent their loosening; sheet iron covers lined with asbestos to protect live parts from dust and mechanical injury, and eliminate the danger of shock from accidental contact; terminals and other parts readily accessible; and field control with adjustable fingers similar in design to the fingers for the armature circuit.

Fourteen-inch Engine Lathe: Young Machine & Tool Co., Worcester, Mass. Engine lathe of the plain type that is intended for repair and general machine shop work. The feed-rod of this machine is so arranged that either a belt or direct gear drive may be obtained. This positive drive for the feed-rod, makes possible the taking of heavy cuts for rapid reduction. The construction of the apron is such that it is impossible to throw in both feeds at once, thus eliminating the danger of stripped gears and spoiled work. All the bearings of this lathe are cast iron and like those on the bed, they are hand-scraped. This lathe is built with either a 6- or 8-foot bed. It will swing 16 inches over the bed and 11 inches over the carriage. A four-step cone pulley is provided, thus giving, by means of the back-gears which have a ratio of 10 to 1, eight speed changes. Change gears are provided for cutting any pitch of thread, ranging from 4 to 36 per inch, inclusive. The maximum distance between the centers with the 6-foot bed is 36 inches. The net weight of the machine is 1470 pounds.

Improved Upright and Radial Drills: Prentice Bros. Co., Worcester, Mass. The radial drills manufactured by this company have been re-designed to adapt them more thoroughly to modern needs. The base has been made more massive beneath the column and the arm is heavily ribbed to resist torsional strains. A feed dial has been conveniently located on the head, which, by the movement of a crank, gives four speed changes, which number may be doubled by a second adjustment. A dial depth gage is also provided which is so arranged that it can be set to zero for any position of the drill. The spindle, through the quick speed change box, has sixteen changes. The machine is equipped with a tapping attachment, a quick return mechanism and an automatic stop motion. The upright machine also contains a number of important changes. The back gears are so arranged that the spindle may be changed from high to low speed or *vice versa* without stopping the machine and simply by the operation of a back-gear lever. Eight spindle speeds are available, and the machine is equipped with the Prentice quick-return and stop motions.

Automatic Nut Tapper: Acme Machinery Co., Cleveland, Ohio. Automatic non-reversing nut tapping machine which taps the nuts straight through as with hand tapping, thus insuring an accurate thread. The nuts to be tapped are placed in a hopper at the top of the machine from which they are fed automatically to a chute that leads down to the tap. At the bottom of this chute there is a reciprocating mechanism that feeds the nuts onto the revolving tap. The machine is provided with three taps which are indexed successively to the tapping position. When the shank of one of these taps is filled with tapped nuts, the tap-carrying mechanism revolves automatically, thus bringing another tap into position, which is then filled as before. The number of nuts that are fed onto the tap is automatically regulated by their thickness. After a tap is filled with nuts, it is indexed from the working position; it then stops automatically, thus enabling the operator to remove it and the tapped nuts. These machines are made in three sizes, designated as Nos. 1, 2 and 3. The first has a capacity for nuts up to ¼ inch, the second to ½ inch, and the third up to 1 inch in diameter. The machine is very rapid as two or three nuts are tapped at a time, and the mechanism is simple and durable.

Four-head Drilling and Facing Machine: Garvin Machine Co., Spring and Varick Sts., New York City. Machine with four heads that is particularly adapted for drilling or reaming four holes simultaneously in such parts as universal joint rings, bevel gear differential spiders, etc. The four heads are located 90 degrees apart on a cross-shaped bed, and the drive is taken from a four-way, right-angle countershaft, there being a separate belt for each spindle. In the center of the bed, and coincident with the axes of the four-spindles, there is a plate to which fixtures may be clamped. The heads have a power feed of 4 inches and a tripping mechanism is provided. The heads are returned to their outward position by a handwheel, and the feeding mechanism is so arranged that they may be adjusted independently if desired. The spindles have threaded ends to permit the use of round box tools, and each has on the inside a drill spindle provided with a Morse taper hole for receiving drills or reamers. The machine is provided with a lubricating system for the cutters, oil being contained in a reservoir in the base. The maximum distance between the ends of the spindles is 10 inches, and the largest size drill that can be used in steel is 7/8 inch. The machine weighs 2800 pounds.

Pipe Threading Machine: Stoever Foundry & Mfg. Co., Myerstown, Pa. Pipe threading machine with capacity for threading pipe from 4 to 12 inches in diameter. By means of a gear-box, in conjunction with a double train of outside gears, ten speeds may be obtained. All the gears are made of carbon-steel castings fitted with bronze bushings, and they run in oil. The speed changes can be made without stopping the machine, and the control of the latter is by means of a clutch operated from the working side of the tool. The headstock is made in one casting similar to that of the lathe, and contains all the principal bearings, thus insuring permanent alignment. The diameter of the spindle on the inside is such that the largest fittings within the machine's capacity can be passed through. The pipe is held by powerful chucks equipped with three independent steel jaws faced with hardened plates. The die-head is of the sliding or floating type that allows for any eccentricity in the pipe. By moving the die-head to one side, the pipe can be cut off within 3 inches of the face of the chuck. The machine is provided with an oil pump for supplying lubricant to the dies, and all bearings have deep receptacles for holding lubricating wool and oil for insuring good lubrication.

All-wrought Steel Pulley: American Pulley Co., Philadelphia, Pa. Improved design of all-wrought steel pulley which is now being manufactured in large sizes ranging from 44 to 60 inches in diameter. These pulleys have eight arms which are built up of two steel plates that are riveted to an annular rim flange and to the flange of an annular hub ring, the rivets passing through both sections of the arm. The hub shell is riveted to a horizontal leg of the same ring, thus giving a very strong construction. The bore of the hubs is standard while the lengths vary. One bushing is furnished with each pulley and extra sizes are carried in stock so that the pulleys may be fitted to shafting of ordinary dimensions. These pulleys are of the parting type which enables them to be put on the shaft without taking it down. The faces are either flat or crowned and pulleys of considerable width are equipped with a double set of arms. A groove is cut in the center of the pulley face, which allows the air to escape from under the belt as the pulley revolves, which results, it is stated, in increasing the horsepower transmitted by at least one-third over that transmitted by a pulley with a plain face. Tests made with this type of pulley show that one 30 inches in diameter with an 8-inch face, will stand a pull of 250 pounds per inch of belt width without slipping.

* * *

BRISTOL-DURAND RADII AVERAGING INSTRUMENT FOR CIRCULAR CHART RECORDS

The extensive use of automatic instruments for recording pressures, temperatures, and electrical units has created a demand for a simple device to quickly determine the average of the records made on such charts, and the integral value for the whole twenty-four hours or whatever time is covered by the record. This demand has been filled by the instrument illustrated herewith, the operation of which is based upon a fundamental plan worked out and patented by Professor W. F. Durand of Stanford University, and constructed in accordance with a novel design developed by William H. Bristol, president of the Bristol Co., Waterbury, Conn.

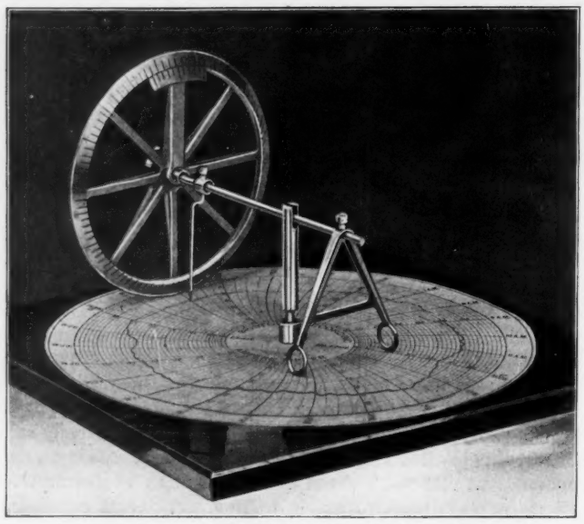
The instrument can be applied for averaging records of any kind on circular charts having uniform graduations, as, for instance, records of watts, amperes, temperature, pressure, etc. Recording instruments equipped with circular charts are therefore made available for a number of applications for which it was previously thought necessary to use the instruments recording on straight lines, or strip record charts. Recording differential pressure gages are coming into use for measuring velocities and volumes of liquids, air or gas flowing in mains, and this integrating device will prove of value for quickly obtaining total volumes of flow for any given period of time.

The simple construction of the instrument is shown by the accompanying illustration. A wooden base with a metal socket is provided for supporting and centering the chart. This socket holds a rotatable pin with a vertical slot at the top to receive the bar which carries the integrating tracer point and triangular support. The vertical groove in the rotatable pin allows the integrating wheel to roll on the chart with uniform pressure due to its own weight. The integrating wheel is six inches in diameter and the rim is graduated into one hundred numbered equal spaces and is fitted with a vernier which makes it possible to easily read with the naked eye to one-tenth of one division on the integrating wheel. The wheel is of such large size it is not necessary to supply any counting device for the number of revolutions. In fact the number of complete revolutions cannot be more than two, even for a record of maximum size on large 12-inch charts.

To operate the instrument, the thumb and forefinger of one hand are applied to the base of the triangular support, which is moved radially, so as to cause the tracer point to continually follow the record curve, while the chart is turned with the other hand. By referring to a line plotted on a sheet of cross-section paper furnished with the instrument, for the par-

ticular record curve that is to be measured, the total reading for the entire twenty-four hours may be taken off directly.

A full explanation of the theory upon which the operation of the instrument depends has been given by Professor Durand, in a paper presented at the New York meeting of the American Society of Mechanical Engineers in 1908. This may be briefly summarized as follows: In applying the instrument, it is necessary to have a uniform radial scale, from which it follows that equal increments in the length of the radius correspond to equal increments in the watts, amperes, temperature or whatever quantity is measured. The integrating wheel, being carried at right angles to the shaft passing through the center, does not turn and give a reading when the tracing point is moved on a straight radial line, but if the tracing point is made to follow a record, the integrating wheel will revolve and the amount of the revolution will correspond to the total of the circumferential elemental components of the record curve, the radial elemental components of the record having no turning effect on the integrating wheel. As the lengths



Instrument for determining the Average Record on Charts of Automatic Recording Gages

of the arcs of concentric circles for given angles or for the entire circumference are proportional to their radii, it is evident that the amount of turning of the integrating wheel, and the reading obtained thereon, will be proportional to the average radius of the record traced.

The instrument is adapted for integrating charts with either straight or curved radial time arcs. The correction necessary for radial time arcs which are curved, may be made after completely tracing the record, by returning the tracing point to a point on the chart having the same radius as the starting point, the movement of the tracing point being along an arc corresponding to the curved radial time arcs.

* * *

SEMI-ANNUAL CONVENTION NATIONAL GAS AND GASOLINE ENGINE TRADES ASSOCIATION

The most successful semi-annual convention in the history of the National Gas and Gasoline Engine Trades Association, was held at the Sinton Hotel, Cincinnati, Ohio, June 13-16 inclusive. About two hundred members and visitors registered and over thirty dealers and manufacturers had products on exhibition. Racine, Wisconsin, was chosen for the next meeting, which will be held some time in December. Several interesting papers were read by prominent authorities, and a number of social events were features of the evenings.

Election does not occur until the next meeting, and the officers whose terms do not expire until then are: President, M. A. Loeb, Cincinnati, Ohio; vice-president, C. D. Hamilton, Elyria, Ohio; treasurer, Otto M. Knoblock, South Bend, Indiana, and secretary, Albert Stritmatter, Cincinnati, Ohio.

* * *

According to statistics quoted by *Page's Weekly*, there are at present about 85,000 private automobiles in use in Great Britain, about 15,000 motor cars used for industrial purposes, and nearly 9000 public service cars.

DON'TS FOR DRAFTSMEN

By H. E. WOOD*

Don't use a loose-jointed T-square.

Don't use a triangle that is too thick.

Don't use instruments with dull points.

Don't make unnecessary lines on a drawing.

Don't use an extremely soft drawing board.

Don't draw with the sun shining on your work.

Don't push a pen or pencil when you can draw them.

Don't design odd or special sized bolts or screws.

Don't use ink that is thick and stringy; new ink is cheaper.

Don't forget that a comprehensive drawing is a valuable asset.

Don't make fancy flourishes and leave off necessary information.

Don't keep a watch lying on your board, open and face toward you.

Don't refuse to listen to what a "jackleg" machinist wants to say.

Don't put perspective drawings and plan drawings on the same sheet.

Don't turn in a drawing until you are sure there are no mistakes on it.

Don't let scales and triangles get dirty, as they will soil your paper.

Don't miss an opportunity to do a little job of machine or bench work.

Don't keep any more instruments lying on the board than you are using.

Don't forget that bicarbonate of soda and water will bleach blue-prints.

Don't put all the patternmaker's dimensions on the machine shop drawings.

Don't use different T-squares and triangles on a complicated drawing.

Don't use too much pounce on tracing cloth, and clear off what you do put on.

Don't leave blue-prints when you are printing them, as they are easily spoiled.

Don't fail to sign all drawings which you make, as it often saves controversy.

Don't forget to backline letters and figures when they are pasted on a tracing.

Don't think that it is always necessary to make machine shop drawings right up to scale.

Don't design curves in machinery when you can make straight flat surfaces answer as well.

Don't forget that oxalate of potash dissolved in water will make a white ink for blue-prints.

Don't let a tracing stand in the sun between the time you start tracing it and the time you finish it.

Don't indicate an oil hole and channel in such a manner that the oil will form an air trap for itself.

Don't fail to mark very distinctly the bearings that should be tight, from the ones that should be loose.

Don't forget that the draftsman can save his employer more money with less exertion, than a machinist can.

Don't let the chief measure anything for you, but if he gives you a measurement, then work faithfully to it.

Don't forget that in some cases a loose bearing is better and much more economical than a tight one.

Don't fail to indicate where oil holes and channels should go, as they are vital points in the design of a machine.

Don't forget that washing soda, gum arabic and water makes a good writing fluid for fine lines on blue-prints.

Don't be reluctant about consulting with both the patternmaker and molder sometimes regarding framework and large castings.

Don't forget that very often a little note of explanation in the corner of a drawing will save the foreman many annoyances.

Don't forget that bread crumbs rubbed thoroughly over a drawing after it is completed will take off the majority of the dirt, and will not disturb the pencil lines perceptibly.

* Address: 182 North 4th St., Newark, N. J.

WELDING A LARGE CRANKSHAFT WITH THERMIT

A large three-throw engine crankshaft with a broken web was recently successfully repaired at the plant of the Goldschmidt Thermit Co., in Jersey City, N. J., by the thermit welding process. Owing to the large size of the shaft, which was 9 inches in diameter and 16 feet in length, and the accuracy of alignment necessary after the broken parts had been welded,

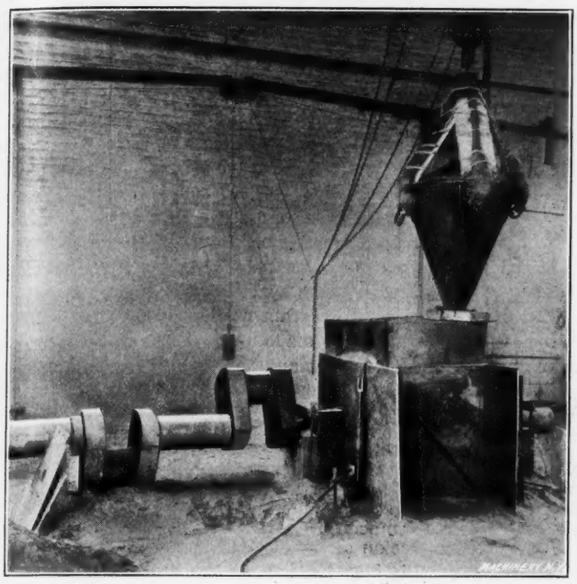


Fig. 1. Large Crankshaft ready to be welded by the Thermit Process

this job is of unusual interest and shows in a rather forcible way the possibilities of the thermit process.

As those familiar with the use of thermit know, it is necessary when making a weld to provide room between the broken ends for the thermit steel. In this instance, an oxy-gas torch was used very effectively for this purpose, and a space two inches wide was quickly cut in the web which had a section of 5 by 15 inches. The crack which made the weld necessary, extended clear across the web between the shaft and crankpin, and penetrated to a depth of 4 inches. The two shaft sections were aligned, prior to welding, by mounting them in V-blocks of the same height that rested on a large surface-plate,

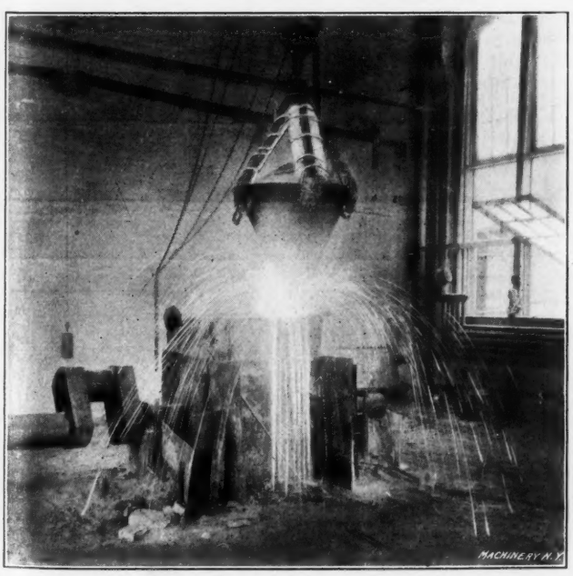


Fig. 2. View showing the Thermit Steel running from the Crucible into the Mold built around the Fractured Web

two blocks being used for each section. After the webs of the broken crank had been set in the proper relation with each other, and the sections were securely clamped, the opening at the break was filled in with a yellow wax matrix after which the mold was built up around the crank. This mold was formed of a sheet iron shell, containing a mixture composed of one-third fire sand, one-third fire clay, and one-third ground fire brick. This mixture forms a very refractory material, which is absolutely necessary owing to the intense heat of the thermit steel. Openings were, of course, left in the mold for a gate and riser, and as parts to be welded by thermit must be pre-heated to prevent them from exerting a chilling effect on the steel, additional openings were made at the bottom of the mold for the insertion of gasoline blow torches. The solid web was pre-heated, as well as the broken one, in order that the expansion on both sides of the crank would be equalized. After the parts had been sufficiently pre-heated, which, of course, also melted the wax previously inserted, thus forming a pocket in the mold, the space surrounding the solid web was filled in with dry sand to prevent any possibility of the molten steel breaking through, and the openings for the torches were also closed. A large inverted cone-shaped crucible, containing 450 pounds of thermit, was then swung by a crane over the gate of the mold as illustrated in Fig. 1. The thermit, which is a mixture of ground aluminum and iron-oxide, was then ignited by means of a special powder which generates the intense heat necessary to start the thermit reaction. In forty-five seconds after a match had been applied to the starting powder, the pre-heated thermit steel was tapped into the mold. Owing to the large amount of thermit used, the chemical reaction was unusually violent

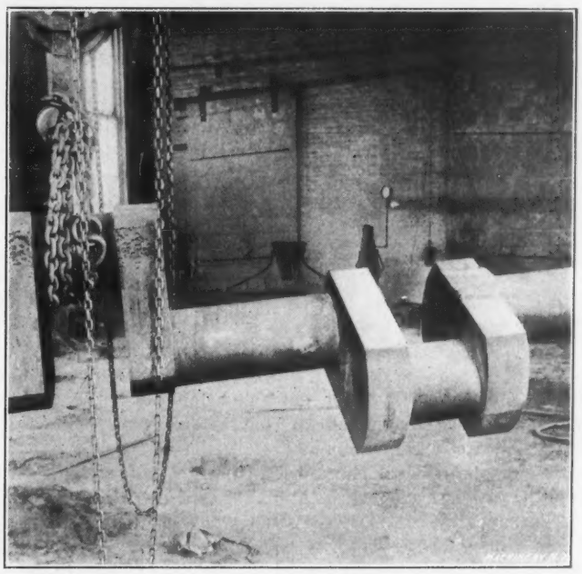


Fig. 3. The Shaft after the Fractured Web (seen to the extreme right) had been welded

and produced showers of brilliant and scintillating sparks which formed a very spectacular pyrotechnical display.

During this reaction, the oxygen of the iron is taken up by the aluminum, which has a strong affinity for it, producing aluminum-oxide (or slag) and superheated thermit steel. Immediately after the reaction ceases, the steel which sinks to the bottom of the crucible is tapped into the mold where it comes into contact with the broken sections and because of its intense heat, which is as high as 5400 degrees Fahrenheit, amalgamates with them to form a homogeneous weld. Fig. 2 shows the steel running from the crucible into the mold, while Fig. 3 is a view showing the welded part of the web.

Of course, thermit has been used on larger and more difficult jobs than the one illustrated, but nevertheless, the successful welding of a section of this size in the comparatively short time required, is an interesting mechanical achievement.

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ADDITIONS TO MEMBERSHIP OF NATIONAL MACHINE TOOL BUILDERS ASSOCIATION

In addition to the list given in the June number, the following concerns have acquired membership in the National Machine Tool Builders' Association: Fay Machine Tool Co., Philadelphia, Pa.; Ohio Machine Tool Co., Kenton, Ohio; Superior Machine Tool Co., Kokomo, Ind. These make 24 new members, and a total of 119.

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The attendance of the spring meeting of the American Society of Mechanical Engineers, held at Atlantic City, N. J., May 31 to June 3 was not as large as that of some of the meetings held heretofore, the registration of members and guests being about 250. The coming joint meeting of the society with the Institution of Mechanical Engineers in England, no doubt caused many who will attend that meeting to forego attending the regular spring session.

A good program was presented, some of the papers being of unusual interest to the engineering profession. A case in point was the paper of Mr. H. J. Freyn, "Some Operating Experiences With Blast Furnace Gas Power Plants." It was conceded to be by far the best exposition of modern gas power practice from the operating standpoint that has been made public. About twenty members took part in the discussion.

The paper by Prof. Walter Rautenstrauch, "A Comparison of Lathe Headstock Characteristics" was a masterly analysis of lathe headstock construction, its object being to show a rational means of working out speed torque combinations and avoiding those combinations which are found in many lathes to be of no practical value. The paper is one that should have the careful attention of machine tool designers generally. In the discussion of the paper, Mr. Carl G. Barth said that certain fundamental formulas deduced on this side of the Atlantic were better than those derived by Dr. Nicholson. For example, the formula $V = \frac{1}{a} + 15$ was valueless for slow cutting speeds as it contained the constant 15. The paper was highly commended by Mr. Taylor, who was disposed to overlook what he considered were comparatively minor faults pointed out by Mr. Barth, and gave the author much credit for the constructive work so valuable to the designers and users of machine tools.

The paper on "Stresses in Curved Machine Members," by Prof. A. L. Jenkins, was followed by a spirited discussion in which conflicting ideas were set forth with more or less convincing force. The thought was expressed that small models freshly cast, containing severe shrinkage stresses, were not safely comparable with full-sized shear frames. Mr. Henry Hess pointed out that the determination of the yield point was all important, and stated that an instrument consisting of a delicate pyrometer and gold-leaf electroscope galvanometer had been developed abroad by which it was possible to test the stresses existing in any part of a machine frame.

The paper by Mr. Wilfred Lewis, "A Shockless Jarring Machine," described a type of molding machine built by the Tabor Manufacturing Company, Philadelphia, Pa., in which the anvil and platen are spring supported. The advantages of the construction claimed are freedom from shocks so destructive to other molds on the molding floor, and the production of homogeneous molds because of avoiding the common causes of flaws and rifts in the sand. The discussion of the paper was characterized by an attack by a competitor which led Mr. F. W. Taylor to deprecate the admission of commercial papers in general. He expressed the thought that unless discussion could be fair and free from trade jealousies, all papers describing commercial machines should be barred from the society's proceedings.

The paper by Prof. Edward C. Schmidt "The Resistance of Freight Trains" dealt with the results of tests made upon the Illinois Central by the railway engineering department of the University of Illinois. The trains tested varied in weight up to 3000 tons. The tests were made on tracks laid with 85-pound rails.

Space will not permit the giving of a full review of the discussion of these or other papers presented. An addition to the list of papers published in the program in the June number was that by Mr. C. K. Lassiter, entitled: "Improved Methods of Finishing Staybolts and Straight and Taper Bolts for Locomotives."

The social event of the meeting was the reception Thursday evening at which honorary membership was conferred on Rear Admiral Melville, U. S. N., retired. Rear-Admiral Melville delivered an address, "The Engineer's Duty as a Citizen."

M. C. B. AND A. R. M. M. ASSOCIATIONS CONVENTIONS

The forty-fourth annual convention of the Master Car Builders' Association and the forty-third annual convention of the American Railway Master Mechanics' Association were held at Atlantic City, N. J., June 15-22, inclusive. Following the custom of alternating the conventions in the matter of priority the Master Car Builders' Association convention was held June 15, 16 and 17, and the Master Mechanics' Association convention June 20, 21 and 22. The Railway Supply Manufacturers' Association held an exposition of railway supplies and apparatus, machine tools, etc., on Young's New Pier simultaneously, as has been the custom for many years. This exhibition of railway supplies is one of the most important annually held in the United States and is growing in importance. Last year the exhibit space was about 65,000 square feet and the year before about 58,000 square feet. This year it was over 71,000 square feet, and still more space would have been used had it been available. Between thirty and forty concerns were turned away that desired to exhibit but could not be accommodated because space was lacking.

The general technical program of the Master Car Builders' Association convention was made up in the usual manner, consisting of topical discussions and papers as follows:

June 15.—Discussion of reports on: "Revision of Standard and Recommended Practice"; "Train Brake and Signal Equipment"; "Brake Shoe Tests"; "Rules for Loading Materials."

June 16.—Discussion of reports on: "Rules of Interchange"; "Coupler and Draft Equipment"; "Car Wheels"; "Safety Appliances"; "Freight Car Trucks"; "Splicing Underframes"; "Car Framing, Roofs and Doors"; "Tank Cars"; "Train Pipe and Connections for Steam Heat."

June 17.—Discussion of reports on: "Consolidation of Master Car Builders and Master Mechanics' Associations"; "Classes of Cars"; "Salt Water Drippings from Refrigerator Cars"; "Mounting Pressures on Wheels and Axles."

Individual paper: "Design of Axle to Carry 50,000 Pounds," by E. D. Nelson, Engineer of Tests, Pennsylvania Railroad.

Discussion: "Springs for Freight Car Trucks."

Discussion of reports on: "Train Lighting and Equipment"; "Lumber Specifications."

The following officers were elected for the M. C. B. Association:

President, T. H. Curtis, L. & N. R. R.
First vice-president, A. Stewart, Southern Ry.
Second vice-president, C. E. Fuller, Union Pacific Ry.
Third vice-president, D. F. Crawford, Pennsylvania Lines.
Treasurer, John S. Lentz, Lehigh Valley R. R.
Executive Committee: J. D. Harris, B. & O. R. R.; C. E. Fuller, U. P. Ry.; and C. A. Seley, C. R. I. & P. Ry.

The technical program of the Master Mechanics' Association was as follows:

June 20.—Discussion of reports on: "Mechanical Stokers"; "Revision of Standards."

Individual paper by W. S. Hayes, Supt. Loco. Operation, Erie R. R.: "Fuel Economies."

Topical Discussions: 1—"Self-dumping Ash Cans," by H. T. Bentley, A. S. M. P., C. & N. W. 2—"Apprenticeship Education," by F. W. Thomas, Supervisor of Apprentices, A., T. & S. F.

Discussion of report on: "Motive Power Development."

June 21.—Discussion of reports on: "Widening Gage on Curves"; "Steel Tires"; "Safety Appliances"; "Superheaters."

Individual paper: "Locomotive Performance under Different Degrees of Superheat," by Prof. C. H. Benjamin, Purdue University.

Individual paper: "Locomotive Frame Construction," by H. T. Bentley, A. S. M. P., C. & N. W. Ry.

Report of Committee on Safety Valves.

Report of Committee on Lumber Specifications.

June 22.—Discussion of report on: "Train Brake and Signal Equipment."

Individual paper: "Freight Train Resistance," by Prof. E. C. Schmidt, University of Illinois.

Discussion of reports on: "Locomotive and Shop Operating Costs"; "Design, Construction and Inspection of Locomotive Boilers"; "Consolidation of Master Mechanics' and Master Car Builders' Associations."

The following officers were elected for the A. R. M. M. Association:

President, C. E. Fuller, Union Pacific Ry.
First vice-president, H. T. Bentley, Chicago & Northwestern.
Second vice-president, D. F. Crawford, Pennsylvania Lines.
Third vice-president, T. Rumney, Erie R. R.
Treasurer, Dr. Angus Sinclair.
Executive Committee members: T. H. Curtis, L. & N. R. R.; F. F. Gaines, Central of Georgia; and G. W. Wildin, N. Y., N. H. & H. R. R.

For several years consolidation of the Master Car Builders' Association and the American Railway Master Mechanics' Association has been discussed without arriving at definite action, but now consolidation seems practically assured. The committee on consolidation presented a report in which it recommended that in view of the fact that neither association would agree to be absorbed by the other, an amalgamated association be formed under the name "The American Railway Mechanical Association." The object of the association shall be the advancement of knowledge concerning the construction and maintenance of cars, locomotives and other railway mechanical appliances by investigation through committees and discussion at conventions. There shall be four classes of members, *i. e.*, active, representative, associate and life. The motion to consolidate has been deferred until another year when investigation of the legal and other aspects of necessary consideration will have been made.

The proportion of machine tool builders exhibiting was not as large as last year. Then out of a total of 228 exhibitors about 50 concerns building machine tools, machinists hand tools and other accessories of the machine shop exhibited. This year there were 42 concerns exhibiting machine tools, accessories and closely allied products out of a total of 255, which number included all exhibitors listed.

Exhibitors of Metal-Working Machines, Accessories and Allied Products

American Vanadium Co., Pittsburg, Pa. Vanadium alloy locomotive parts, including 9-inch locomotive axle bent double under 14,000-ton press pressure to show its remarkable homogeneity and elasticity; 2 x 14-inch vanadium steel eye-bar for new Quebec bridge, the largest eye-bar ever made.

Armstrong-Blum Mfg. Co., Chicago, Ill. Portable grinders for lathes and planers; hand lever punches and shears; "Marvel" power hack-saw machine.

Armstrong Bros. Tool Co., Chicago, Ill. Drop forged lathe and planer tool-holders and other machine shop specialties.

Besly & Co., Charles H., Chicago, Ill. Besly spiral disk grinders (see MACHINERY, May, 1910, for description); spiral circles; forged taps, etc.

Buck Boring Bar Co., Huntington, W. Va. Roughing and finishing expansible cutter boring bar for car wheels.

Celfor Tool Co., Chicago, Ill. Celfor high-speed drills, three-lip drills, flat drills, reamers, countersinks, etc.; tests of Celfor drills on Colburn high-duty drill.

Chicago Pneumatic Tool Co., Chicago, Ill. Belt-driven air compressor for pneumatic drills.

Chisholm & Moore Mfg. Co., Cleveland, Ohio. Cyclone high-speed chain hoists from ½ ton to 30-ton capacity; I-beam trolleys, etc.

Colburn Machine Tool Co., Franklin, Pa. Motor-driven high-duty drilling machine in operation.

Cooper Hewitt Electric Co., New York. Mercury vapor lamps and mercury arc rectifiers for operating same with electric current.

Davis-Bournonville Co., New York. Repaired locomotive parts welded by the oxy-acetylene autogenous process.

Disston & Sons, Inc., Henry, Philadelphia, Pa. Hack saws; regular and superfine files; hand saws and other carpenter's tools.

Dixon Crucible Co., Joseph, Jersey City, N. J. Graphite products for locomotives and cars.

Duff Mfg. Co., Pittsburg, Pa. Hydraulic jacks, ball bearing jacks, etc.

Faessler Mfg. Co., J., Moberly, Mo. Improved sectional tube expanders, etc.

Fairbanks-Morse & Co., Chicago, Ill. Hydraulic and screw jacks; track drills, etc.

Foster, Walter H., New York. Lassiter locomotive bolt turning machine; staybolt threading and reducing machine; Potter & Johnston chucking lathe; staybolt threading machine; automatic nut tapping machine; die chaser grinder, etc.

General Electric Co., Schenectady, N. Y. Electric tool hardening furnace; motor-driven machine tools, Curtiss turbo-generator, etc.

Goldschmidt Thermit Co., New York. Apparatus illustrating the Thermit welding process; metals free from carbon produced by the Thermit process, etc.

Greene, Tweed & Co., New York. Reversible ratchet wrenches; packing.

Hammett, H. G., Troy, N. Y. Locomotive link grinder, etc.

Harrington, Edwin, Son & Co., Inc., Philadelphia, Pa. Chain hoists; I-beam trolleys, etc.

Independent Pneumatic Tool Co., Chicago, Ill. Piston air drills; pneumatic chipping, riveting, calking and flue beading hammers, etc.

Keystone Drop Forge Works, Chester, Pa. Drop forgings, including machine handles, etc.

Landis Machine Co., Waynesboro, Pa. Self-opening Landis die for turret lathes; semi-automatic die head for pipe threading machines; and double-head motor-driven bolt threading machine; single spindle ½-inch bolt threading machine.

Landis Tool Co., Waynesboro, Pa. Cylindrical gap grinding machine, 16 x 72 inches, in operation, especially designed for railroad work; universal cylindrical grinder.

Manning, Maxwell & Moore, Inc., New York. 24-inch F. E. Reed motor-driven engine lathe; 24-inch high-duty Foote-Burt drill; 36-inch Foote-Burt high-duty drill; 26 by 8 by 8-foot single-head motor-driven shaper; 4½-inch Gridley single-spindle motor-driven turret lathe; 1¼-inch Gridley four-spindle turret lathe; No. 4 Hendey motor-driven knee-type milling machine; 16-inch Hendey geared head engine lathe; Dreses motor-driven full universal radial drill; 1½-inch National wedge grip heading and forging machine; National motor-driven double head bolt cutter; National die chaser sharpener; Elmore (Dwight Slate Co.) high-duty ball bearing single-spindle sensitive drill press, etc.

National-Acme Mfg. Co., Cleveland, Ohio. Multiple-spindle automatic screw machine in operation.

Niles-Bement-Pond Co., New York. 20-inch LeBlond engine lathe with all-geared heads; three-step cone pulley; LeBlond double back-geared lathe head; LeBlond universal milling machine; pneumatic clamp tool-post for locomotive driving wheel lathes and car wheel lathes; Pratt & Whitney small tools, etc.

Norton Co., Worcester, Mass. Alundum grinding wheels and other alundum abrasive products.

Revolute Machine Co., New York. Continuous electric blueprinting machine.

Sellers, William, & Co., Inc., Philadelphia, Pa. Turret tool-post for 42-inch car wheel lathe; turret tool-post for high-duty locomotive driving wheel lathe; set of three drivers for 42-inch car wheel lathe, etc.

Stoever Foundry & Mfg. Co., Myerstown, Pa. Automatic pipe bending machine; pipe threading and cutting-off machine.

Taylor Mfg. Co., James L., Bloomfield, N. J. Machinists' patternmakers' and boilermakers' clamps.

Tindel-Morris Co., Eddystone, Pa. Cold sawing machine and inserted tooth cold saws; grinders, etc.

Toledo Pipe Threading Machine Co., Toledo, Ohio. Hand-operated pipe threading tools, etc.

Underwood & Co., H. B., Philadelphia, Pa. Portable cylinder boring bar; portable crank-pin turning machine; portable machine for facing off riveting on crank-pins; locomotive pedestal facing machine.

Union Mfg. Co., New Britain, Conn. Lathe, planer, drill, valve, boring mill and car-wheel chucks.

Walworth Mfg. Co., Boston, Mass. Stillson wrenches; Miller ratchet stocks and dies, etc.

Watson-Stillman Co., New York. Hydraulic jacks; centrifugal pumps, etc.

Westinghouse Air Brake Co., Pittsburg, Pa. Air brakes, seven-car passenger train rack equipped with PC equipment, etc.

Westinghouse Machine Co., Pittsburg, Pa. LeBlanc steam condenser and LeBlanc vacuum pump, turbine driven.

Yale & Towne Mfg. Co., New York. Electric hoists, I-beam trolleys, chain blocks, etc.

* * *

DRY HIGH-SPEED TOOL GRINDING

Fine surface cracks are often found on high-speed steel tools after grinding, especially when grinding with a wet wheel. A class of work that is particularly troublesome in this respect is hardened disks such as slitting saws, washers, etc., ground on the side. The cracks develop radially, and although of microscopic depth and really not injurious in most work, they give it a defective appearance and cause rejections and losses. It is pretty well settled now that these cracks are caused by momentary overheating of the steel which results in local expansion sufficient to exceed the elastic limit of the metal. The cracks grow with each revolution of the work, radially to the edge of the disk. The remedy is to use a soft wheel and grind *dry*. When work is ground dry with a soft wheel the pressure is reduced as compared with wet grinding, and thus local overheating is also reduced. Many have the idea that if tools are ground wet there is no danger of overheating. This is a mistake; water cannot be forced to the exact point of contact of the wheel and work, and its local cooling effect is comparatively slight. The effect of the water in wet grinding is to keep down the temperature of the wheel and work generally, but not locally.

On account of the tendency to exceed the safe pressure and ruin tools by overheating when grinding with a wet wheel, some tool experts now recommend dry wheels for all high-speed steel tool grinding. If water is used, it should be used only with the idea of keeping down dust and washing the wheel and tool, and not as a cooling medium of much efficiency.

PERSONALS

Robert S. Alter, secretary of the American Tool Works Co., Cincinnati, Ohio, was married June 25 to Margaret Carel Maury.

George S. De Laney, superintendent of the Stevens-Duryea Automobile Co., Chicopee Falls, Mass., has been promoted to the position of manager.

Alex. Luchars, publisher of MACHINERY, sailed with his family on the *Oceanic* June 15 for a three month's tour in Europe, principally by automobile.

R. D. Reed, for several years with the H. B. Smith Co., Westfield, Mass., has been made manager of the Springfield Foundry Co.'s new plant in Springfield, Mass.

Wilson P. Hunt, of the Moline Tool Co., Moline Ill., recently took an extended eastern trip, including Toronto, Buffalo, National Machine Tool Builders' Association convention at Rochester, Pittsburg and Cincinnati.

F. H. Wilder has been promoted from the position of foreman of the "J and L" department to the position of foreman of the chassis assembling department of the automobile section of the New Departure Mfg. Co., Bristol, Conn.

W. S. Rogers, president of the Bantam Anti-Friction Co., Bantam, Conn., is now on his annual trip to Germany visiting his company's allied German companies, manufacturing balls and ball bearings, and arranging for the coming year's contracts. Mr. Rogers expects to attend the meeting of the American Society of Mechanical Engineers in joint convention with the British Institute of Mechanical Engineers in Manchester and London in July.

C. H. Kingsbury, for the past twelve years manager of the Niles-Bement-Pond Co.'s Boston office, will take a vacation of several months on account of ill-health. Previous to his departure the managers and heads of departments of the Hill-Clarke & Co., Inc., Chandler & Farquhar Co., Prentiss Tool & Supply Co., and Manning, Maxwell & Moore called upon Mr. Kingsbury and extended their best wishes for rapid return of health. They presented him with a Masonic charm, suitably engraved as a token of friendship. Mr. M. Estabrook of the New York office will have charge of the Boston office during Mr. Kingsbury's absence.

Louis I. Wightman, for the past six years advertising manager for the Ingersoll-Rand Co., 11 Broadway, New York, has resigned his position, the resignation taking effect August 1, and will open an office in New York City as an independent specialist in machinery advertising, handling the accounts of manufacturers of machinery and engineering products. Mr. Wightman is well fitted for this line of work by his wide experience in managing one of the largest advertising departments in the machinery field, which was preceded by some years' experience in practical mechanical and electrical engineering, construction work, machine design and manufacture and machinery selling. Mr. Wightman is a graduate engineer, the author of a text-book on compressed air, and an authority on compressed air subjects.

* * *

OBITUARIES

James Wilson, master mechanic of No. 5 machine shop, Ludlow Mfg. Associates, Ludlow, Mass., died at his home in Ludlow, June 5, aged forty-four years.

W. P. Bettendorf, president of the Bettendorf Steel Car Co., Davenport, Iowa, died at his home in Davenport, June 3, in the fifty-third year of his age. Mr. Bettendorf organized the company of which he was president and built the works which cover thirty acres of ground. A recent addition is 2100 feet long. He was the inventor of several improvements in agricultural machinery and railway cars.

John H. Whittemore, a pioneer in the malleable iron industry, died at his home in Naugatuck, Conn., May 28 after a short illness. Mr. Whittemore began in the malleable iron business in 1858, the firm name being Tuttle & Whittemore. After several years the concern was reorganized and the name changed to the Naugatuck Malleable Iron Co. Mr. Whittemore was interested in the malleable iron industry in Cleveland, Chicago, Indianapolis, Toledo, Bridgeport and New Britain.

Charles E. Bailey, a veteran armorer, who retired fifteen years ago after thirty-one years of service as foreman in the Water Shops, United States Armory, Springfield, Mass., and a total of forty-five years in the government shops, died at his home in Springfield, Mass., May 10, aged eighty-three years. Mr. Bailey devised and perfected many valuable fixtures and tools. Col. Benton during his term as commandant recommended to the government that Mr. Bailey receive liberal extra pay for valuable service, but the grant was never made. At the time the Rock Island, Ill. shops were being planned, Mr. Bailey was sent there to prepare plans for the lay-out of machinery. He had charge of the armory exhibit at the Chicago World's Fair in 1903. He was a native of South Berwick, Me.

William P. Davis

D. Wheeler Swift, inventor of printing and automatic machinery used in the manufacture of envelopes, died of paralysis at his home in Worcester, Mass., June 14, aged seventy years. Mr. Swift went to Worcester in 1864 and entered the employ of David Whitcomb who was just starting in the envelope business. He worked twenty years as superintendent for the Whitcomb Envelope Co., during which period he and his brother produced and perfected new machinery which would successfully fold and gum envelopes. In 1884 the Logan, Swift & Brigham Envelope Co. was organized and Mr. Swift was made president. His inventions of new machinery were largely responsible for the success of the company. The United States Envelope Co. was founded in 1898 and Mr. Swift was elected director and mechanical superintendent, which position he filled during the remainder of his life.

John M. Rogers, of the John M. Rogers Works, Inc., Gloucester City, N. J., died in the Cooper Hospital, Camden, N. J., June 4, following an operation, aged sixty-eight years. He was born in Key West, Fla., and his early life was spent as purser on the side-wheel steamer *Golden Rule*, running between New York and the Isthmus of Panama. After the wreck of this vessel off Roncador Reef, he spent a few years in the employ of his uncle, the late Francis Morris. After his marriage he resided in Wilmington, Del., where he entered the printing business, having full charge of the John M. Rogers Press for several years. In later years he became actively engaged in the machine business, being one of the pioneers in the manufacture of measuring tools. Mr. Rogers developed the John M. Rogers Works, Inc., Gloucester City, N. J., of which he was president at the time of his death. He leaves a widow and two sons, J. Morris Rogers and Francis C. Rogers.

William P. Davis, president of the W. P. Davis Machine Co., Rochester, N. Y., died at his home in that city May 30, aged sixty years. Mr. Davis was born in Lima, N. Y., in 1850 and was educated in the public schools of Honeoye Falls. Early in life he manifested a strong mechanical bent, and entered a machine shop at Auburn when only fourteen years old. Eight years later Mr. Davis started a machine shop of his own in North Bloomfield, N. Y., and later removed to Canandaigua, N. Y., where he remained three years. In 1890 he moved to Rochester, where quarters were occupied in the Borseline building at the foot of Commercial St. In 1894 he organized the W. P. Davis Machine Co., and in 1897 the present large brick plant in which about 200 men are employed was erected on St. Paul St. near the New York Central station. Mr. Davis was a charter member of the National Machine Tool Builders' Association and was prominently identified with it from the time of its organization, having always filled an official position. He was treasurer of the association at the time of his death, which office he had held since 1906. It was largely through his efforts that the last meeting of the association was held in Rochester but his last illness prevented him taking part. He leaves a widow, one daughter, an aged father and brother, Charles F. Davis, secretary and treasurer of the W. P. Davis Machine Co.

* * *

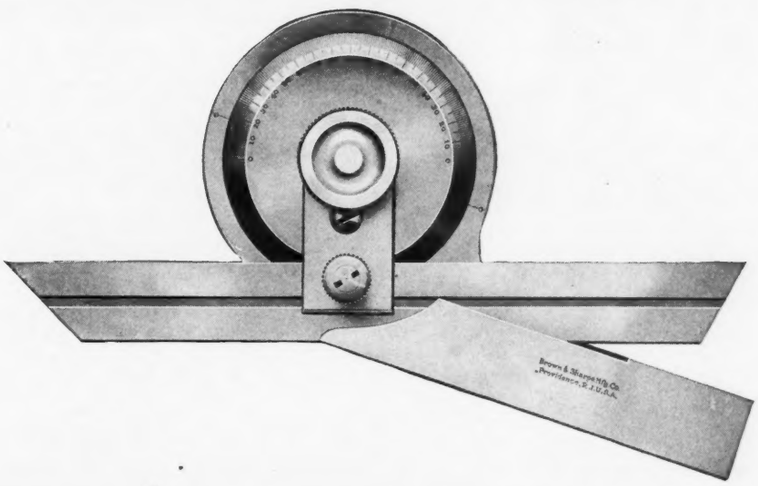
There have been many attempts to formulate an explanation of a steam turbine's operation which will be understandable by the non-technical man. One of the simplest we have seen is given by the *Daily Star* of Lincoln, Neb.:

"The turbine stands about 6 feet high and is about 6 feet through. It is cylindrical. The turbine wheels inside are used to keep the acids and zinc stirred so as to generate electricity rapidly."

This was contained in a comment on an accident to a turbo-generator. No wonder it blew up!—*Engineering News.*

Here is a new tool, accurate and inexpensive, for laying out or establishing angles.

B. & S. IMPROVED BEVEL PROTRACTOR



The protractor is made with one side flat so that it can be laid flat on the work or paper—a feature that adds greatly to the utility of the tool.

The blade can be moved separately from the dial and can be moved back and forth its entire length. It is clamped independently of the dial and this adapts the tool for work where other protractors cannot be used.

DIAL GRADUATED TO DEGREES

All graduations on the dial are accurately made, the graduations reading to degrees. These graduations extend over an arc of 180°, reading from 0 to 90° from each extremity of the arc. The tool is intended for work that does not require a Vernier, a point wherein it differs from the Universal Bevel Protractor. The dial turns on a large central stud which is hardened to prevent wear. When the dial is set, this clamp nut holds it rigidly in place, doing away with all danger of slipping and consequent inaccuracies in the measurements.

The Protractors are made in two sizes, with 6" or 12" blades.

Send for new folder.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

COMING EVENTS

June 20-July 6.—Detroit Industrial Exposition, Detroit, Mich., under the auspices of the Detroit Board of Commerce to accelerate the city's industry and commerce. The exposition grounds will be on the Detroit River where a large exposition building is being erected to be used in conjunction with the Wayne Pavilion. W. G. Rose, manager, Detroit Board of Commerce, Detroit, Mich.

July 26-29.—Joint meeting of the American Society of Mechanical Engineers and the British Institute of Mechanical Engineers in Birmingham and London, England.

July 28-30.—Convention of the Society of Automobile Engineers, Detroit, Mich. Subjects for discussion: "Gears," "Commercial Vehicles," "The Electric Vehicle," "Gasoline Motors," "Metals and Treatment," "Wheel Rims, Tires, etc.," "Bearings," "Driver's Seat on Left-hand or Right-hand," "Final Drive," "Factory Systems," "Contests," etc. Howard E. Coffin, president, 1451 Broadway, New York.

August 16-19.—Annual convention of Traveling Engineers' Association, Clifton Hotel, Niagara Falls, Canada. Subjects to be discussed are: "Fuel Economy," "Superheating," "Education of Firemen," "Development of Air Brake Equipment," "Locomotive Lubrication," and "New Valve Gears." W. A. Thompson, secretary, N. Y. C. Car Shops, East Buffalo, New York.

October 10-14.—Annual convention of the American Street and Interurban Railway Association, Atlantic City, N. J. A. C. Donecker, secretary and treasurer, 29 West 39th St., New York.

SOCIETIES AND COLLEGES

BULLETIN OF SYRACUSE UNIVERSITY, April, 1910.
General catalogue and catalogue of the summer session which is held July 5 to August 16. Address the University of Syracuse, Syracuse, N. Y.

SOCIETY OF AUTOMOBILE ENGINEERS, 1451 Broadway, New York, has taken over the work of the Association of Licensed Automobile Manufacturers' mechanical branch and will broaden the activity of the association in its relation to the motor car industry. Its object is to collect, scientifically arrange, and disseminate motor car engineering data and information.

NEW BOOKS AND PAMPHLETS

CONCRETE FROM SAND MOLDS, by A. A. Houghton. 145 pages, 5½ by 7½ inches, 12 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $2.
This interesting book describes the processes of molding concrete, especially ornamental forms, in sand molds, the practice being similar to molding for metal castings. It is a revived art, there being evidence to show that it was practiced by the Romans. The work describes the process of preparing and mixing the sand for hardened sand molds, how to make sand molds from wood and metal patterns, construction of sand molds from clay, plaster, concrete, or other patterns, method of making cores, how to combine molds to mold large monolithic work, molding concrete brick with sand molds, facing molds with crushed granite, marble flour or any other material, etc.

THE POLYTECHNIC ENGINEER. 144 pages, 6 x 9 inches. Illustrated. Published by the Polytechnic Institute of Brooklyn, New York.
This work is published annually by the undergraduates of the Polytechnic Institute. Volume X contains the roster of the corporation, officers, officers of instruction, Polytechnic Institute engineering societies, board of editors, and among others the following technical articles: "Negative Track-Feeders," by Samuel Sheldon; "Some Experiments on the Casehardening of Steel by Gases," by John C. Olsen, John R. Brierley, and John S. Weiffenback; "Train Resistance Formulas and Speed-Time Relations," by William D. Ennis; "Deflections of Beams with Variable Moments of Inertia," by C. W. Hudson; "Gyration Stresses in Shafts," by D. D. Barlow; "Automobile Transmissions," by Edward O. Ericson; "Continuous Indicator Diagrams," by M. G. Farrell.

CATALOGUES AND CIRCULARS

SPRAGUE ELECTRIC CO., 527 West 34th St., New York. Catalogue of electric hoists.

GENERAL ELECTRIC CO., Schenectady, N. Y. 18th Annual report to the stock-holders.

INGERSOLL-RAND CO., 11 Broadway, New York. Bulletin No. 3017 on gas compressors.

SPRAGUE ELECTRIC CO., 527 West 34th St., New York. Catalogue of flexible steel armored hose for compressed air or steam.

EMERSON ELECTRIC & MFG. CO., St. Louis, Mo. Bulletin No. 3707 of electric buffing lathes for alternating and direct currents.

GRATON & KNIGHT MFG. CO., Worcester, Mass. Circular entitled "What Mr. Denniston Says," advertising G. & K. leather belting.

NATIONAL BRAKE & ELECTRIC CO., Milwaukee, Wis. Bulletin No. 389 on types of National emergency and variable release brake valves.

TURNER-FRICKE MFG. CO., Sharon, Pa. Catalogue of Turner-Fricke gas engines, illustrating and describing the construction in detail.

WESTINGHOUSE MACHINE CO., East Pittsburg, Pa. Circular W-M 501 on the Westinghouse-Le Blanc condensers for steam power plants.

REYNOLDS MACHINERY CO., Moline, Ill. Circular of Reynolds gear hobbing machine illustrated and described in the April, 1909, issue of MACHINERY.

INGERSOLL-RAND CO., 111 Broadway, New York. Bulletins Nos. 306 and 3023 on Class O duplex steam-driven air compressors, and Class OC duplex Corliss driven air compressors.

MIAMI VALLEY MACHINE TOOL CO., Dayton, Ohio. Blotter advertising 13-inch and 16-inch lathes; plain, cutter and reamer grinders; universal tool and cutter grinders; 12-inch and 14-inch drills, etc.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4737, illustrating and describing electric hardening furnaces designed for the hardening and tempering of tool steel. (See MACHINERY, November, 1909.)

UNION MFG. CO., New Britain, Conn. Circular advertising economical iron castings which in quality and net cost should give the highest satisfaction. The company has specialized on the work for forty years.

CARB-OX CO., Rogers Park, Chicago, Ill. Catalogue of gas analysis instruments and allied specialties, used in the determination of boiler efficiencies, gas producers, etc., whether the fuel be coal, oil, gas or refuse.

NATIONAL BRAKE & ELECTRIC CO., Milwaukee, Wis., Bulletin No. 388, "Types of National Motorman's Air Brake Valves." These air brake valves are designed for street railway urban and interurban service.

CHICAGO BEARING METAL CO., Chicago, Ill. *The Graphose Age* being the second number of a publication devoted to graphose-bronze, white brass, brass castings, babbitt metals, solder and other products of the company.

CRESCENT MACHINE CO., Leetonia, Ohio. Catalogue of Crescent wood-working machinery comprising band saws, universal saw tables, shapers, jointers, variety wood-workers, planers, planers and matchers, swing cut-off saw, disk grinders, etc.

AERIAL NAVIGATION CO. OF AMERICA, Girard, Kans. Circular illustrating and describing the Call aviation engine built in two sizes—45 horsepower and 90 horsepower, weight 135 and 225 pounds respectively, price $700 and $1,200.

NEGRETTI & ZAMBRA, 38 Holborn Viaduct, London, E. C., England. Revised price list and instructions for acrometer, an instrument giving direct readings of the maximum cylinder pressure of internal combustion engines, compression, vacuum, etc.

RISDON TOOL & MACHINE CO., 63 Canal St., Waterbury, Conn. Circular giving official organization and statement of its activities. The company designs and makes dies, models, tools, sub-press dies, light machinery, and does all kinds of light manufacturing.

UNION MFG. CO., New Britain, Conn. Catalogue of combination, universal, independent, geared scroll, scroll combination, planer, boring mill, car wheel, grinding machine, box body, round body and drill chucks. The company also builds special chucks of every description to order.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4732, containing upwards of fifty illustrations of installations of Curtiss steam turbine generators of various classes. The bulletin should interest central station managers and others concerned with the production of large powers.

W. F. & JOHN BARNES CO., Rockford, Ill. Catalogue of the various styles and sizes of Barnes upright drills, horizontal radial drills, gang drills, drill press attachments and other machine tools. This catalogue is attractively arranged, and contains much that is of interest relating to drilling machinery.

PAWLING & HARNISCHFEGER, Milwaukee, Wis. Bulletin No. 18, illustrating and describing traveling electric hoists. Besides showing the various types of hoists made, the bulletin illustrates a number of interesting installations. It will interest the plant engineer, superintendent and other responsible men desirous of saving costs in handling material.

CLING-SURFACE CO., Buffalo, N. Y. Report of an interesting experience in the treating of a painted ten-inch heavy canvas belt which had been treated with "Cling-Surface" after having been condemned as being no good. After being treated with the "Cling-Surface," the belt ran at 850 R. P. M. and transmitted 85 H. P. without sign of slip, although the sag was 23 inches between pulleys.

TATE JONES & CO., INC., Pittsburg, Pa. Circular No. 129 on fuel oil burning equipment for open-hearth furnaces. The Kirkwood oil burner is illustrated and described; also reversing valve stand, pumping, heating and regulating systems, etc. Views are shown of installations of the apparatus in foundries and steel works, and a piping diagram of oil fuel installation in an open-hearth steel plant is included.

L. A. WILLIAMSON CO., 79 Milk St., Boston, Mass. Booklet describing Williamson's electric "Flexilyte," which is a portable electric light extension containing a cord that can be unwound to any desired length and which is held fast by a sliding catch. The fixture is neat in appearance and convenient to use, there being no extra length of cord hanging in loops, the excess length being coiled within the fixture.

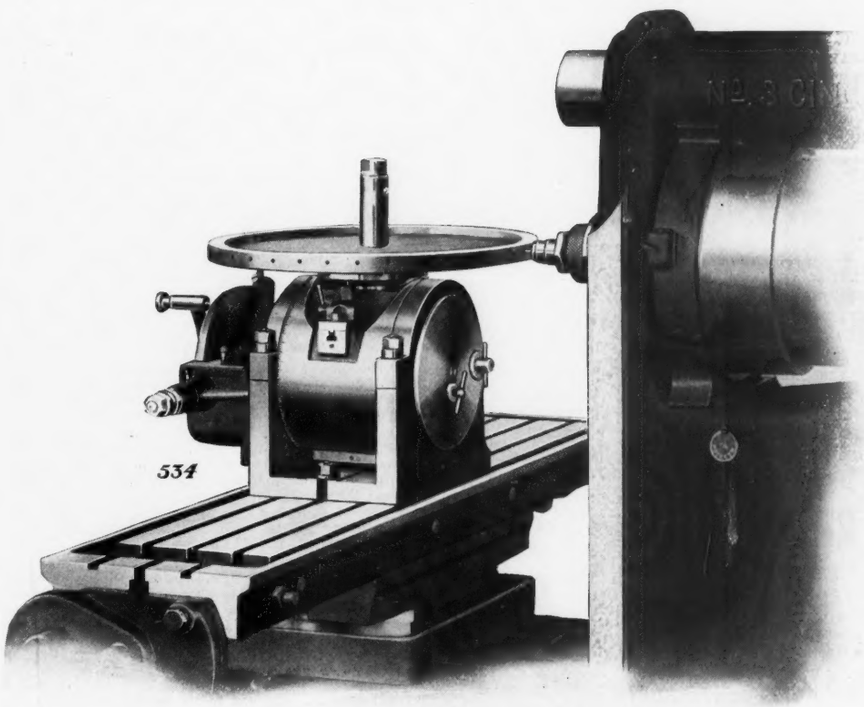
DE LAVAL STEAM TURBINE CO., Trenton, N. J. Treatise on De Laval centrifugal pumps, giving the results of tests and illustrations and descriptions of various types of centrifugal pumps for all classes of service. The characteristic curves of several sizes of pumps designed to meet the requirements of representative classes of service are reproduced, and testing apparatus illustrated. The construction of pumps is shown disassembled, and much matter of engineering interest is included. The treatise is recommended to the attention of all interested in the possible use and operation of centrifugal pumps.

NATIONAL-ACME MFG. CO., Cleveland, Ohio. Parts and tools catalogue for the Acme automatic multiple-spindle screw machine. It illustrates the component parts of head, spindles in head, spindles in slide, main slide, cut-off and forming cross-slides, top slides, feed mechanism, spindle stopping mechanism, power transmission—drive, power transmission—control, power transmission—back gears, power transmission—housing, countershaft, frame, oil system, stock carriage, cams, chucks, box-tools, tools for top slides, tools for cross-slides, dies and drill-holders, etc. The book is intended particularly for men in charge of automatics and automatic screw machine departments. Copies are sent free upon request.

GREEN FUEL ECONOMIZER CO., Matteawan, N. Y. Pamphlet entitled "Foundry Heating System," containing detailed descriptions of two novel installations recently made by the company. In one of these installations, a foundry of 515,000 cubic feet capacity and having walls made up entirely of glass was successfully heated by a small four-section "Positivflo" heater. The pamphlet also describes a novel arrangement of ducts whereby the heat is supplied just where needed by the workmen, at the same time furnishing them with fresh air, and forcing the smoke and gases out of the building through the skylight. By using the right number of heater sections, and regulating the volume of air delivered, it is also possible to maintain the foundry at such temperature at night that cores and molds will be prevented from freezing.

WARD LEONARD ELECTRIC CO., Bronxville, N. Y., recently published a pamphlet describing a new generator and storage battery outfit for automobile lighting. The ingenious feature of the device is the provision of an electrically controlled magnetic clutch between the engine and the generator. This control connects the generator with the power whenever the gear shifting lever is moved from the neutral position. When the engine and generator have speeded up so that the voltage induced becomes slightly greater than that of the storage battery, an automatic electric switch connection is closed between them, charging the battery. Whenever the voltage of the generator falls below that of the cells, this switch automatically opens, preventing an improper discharge of the battery. When the engine and generator speeds become so high that the charging amperes reach a predetermined amount, an automatic electric switch breaks the circuit to the clutch, thus slowing down the dynamo armature. When this again has been reduced below the critical point, the clutch circuit is thrown in again, accelerating the dynamo. It will thus be seen that the dynamo speed is kept within predetermined speed limits, no matter how high the engine speed attained. Two storage batteries are provided, either of which may be used for the lighting service, and the other for ignition. The storage feature provides for both light and ignition over periods when the engine has been stopped for some time.

CINCINNATI UNIVERSAL TOOL ROOM MILLERS



Thirty-six holes ¼″ diameter are spaced on the periphery of a 19″ disk rigidly held on a 12″ Index Head. They are first drilled, then bored a trifle under size, and finally reamed to a plug gauge fit with a specially ground ¼″ end mill. The error between holes is less than one thousandth (+.001″). To get such results requires a miller that is accurate all over.

This is a good illustration of the best method of handling work of larger diameter than the index centers will swing. The swivel trunnions on our Dividing Head are large in diameter and fully protected in all positions, insuring permanency of alignment at any angle to which the spindle may be set.

Cincinnati Millers are as famous for their accuracy as for their productive capacity.

The Cincinnati Milling Machine Company

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Schuchardt & Schutte, Berlin, Stockholm, St. Petersburg and Copenhagen. Alfred H. Schutte, Cologne, Brussels, Milan, Paris, Barcelona and Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.

CANADIAN AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver.

AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne.

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Plainer Letters and Figures in the Drafting-Room and Shop. Designer	929	625
Fixture for Locating Cams on Cam-Shafts	929	625
A Convenient Bulletin-Board. James C. Davis	929	625
Method of Preparing Tracing Cloth. Robert A. Lachmann	930	626
Turning a Radius with a Compound Rest. Jack E. Hailstone	930	626
A Simple Dotting Arrangement. Fred Horner	930	626
Speeds and Feeds for Carbon or High-Speed Twist Drills. V. Brockbank	931	627
A Fixture for Straddle Milling. C. Nosrac	931	627
Estimating Weights of Rolled Stock. Robert S. Brown	932	628
Dividing a Circle into Equal Parts. George B. Grant	932	628
Making Embossing Rollers. L. Rosenthal	933	629
Calculating the Weights of Steel Plates. Frank W. Holcomb	933	629
Shop Kinks	934	630
Shop Receipts and Formulas	937	633
How and Why	938	634
Aeroplane Flights—Albany to New York—New York to Philadelphia and Return	940	636
J. H. Williams & Co.'s Motion Sample Boards	940	636
New Machinery and Tools	941	637
Bristol-Durand Radii Averaging Instrument for Circular Chart Records	961	657
Dont's for Draftsmen	962	658
Welding a Large Crankshaft with Thermit	963	659
Spring Meeting of the American Society of Mechanical Engineers	964	660
M. C. B. and A. R. M. M. Associations Convention.	964	660

This whole mechanism would seem to be as well adapted for development into a railroad car lighting apparatus, as for automobile use.

International Harvester Co., Chicago, Ill. Circular describing plan of industrial accident department of the International Harvester Co. and associated companies, comprising International Harvester Co. of Canada, Ltd., International Flax & Twine Co., Wisconsin Steel Co., Illinois Northern Ry., Chicago & West Pullman & Southern Ry., Owasco River Ry., and Deering Southwestern Ry. The scale of compensation provided is as follows: In case of death there will be paid three years' average wages, but not less than $1,500 nor more than $4,000. In case of the loss of a hand or foot, one and one-half years' wages, but in no event less than $500 nor more than $2,000. For the loss of both hands or both feet, or one hand and one foot, four years' wages, but in no event less than $2,000. In case of other injuries, one-fourth wages during the first thirty days of disability; if disability continues beyond thirty days, one-half wages during the continuance thereof, but not for more than two years from the date of the accident. Thereafter, if total disability continues, a pension will be paid. Provision is made so that the employes may increase the benefits to be paid during the first thirty days of disability to an amount equal to half-wages. This is accomplished by the creation of a benefit fund, to paid by the company, be sufficient to provide half-pay for all injured which employes earning $50 per month or less will contribute 6 cents a month, employes earning more than $50 and less than $100, 8 cents These small contributions will, together with the one-fourth wages a month, and employes earning more than $100, 10 cents per month, employes during the first thirty days of disability.

TRADE NOTES

Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass., has made plans for building a three-story addition, 50 by 100 feet.

Lees-Bradner Co., Cleveland, Ohio, manufacturer of gear generating machines, is building an addition, 30 x 50 feet, to its factory.

Deane Steam Pump Co., Holyoke, Mass., branch of the International Steam Pump Co., will build a new foundry plant 200 feet long, 150 feet wide.

C. W. Hunt Co., New York, builder of coal handling, conveying and hoisting machinery, has appointed C. T. Anderson manager of the Chicago office, 1616 Fisher Bldg.

Sebastian Lathe Co., Covington, Ky., has just completed a 45 x 80 foot single story, concrete floor, trussed roof addition to its shop, and reports orders ahead for the next three months.

Knox Automobile Co., Springfield, Mass., is building an addition to its plant, 66 x 125 feet, six stories and basement. The addition will increase the company's manufacturing space about 25 per cent.

Wisconsin Engine Co., Corliss, Wis., has appointed George B. Foster its Chicago sales manager. His office will be located in the Fisher Building, Chicago. Mr. Foster represents the company in the Chicago district.

Springfield Foundry Co., Springfield, Mass, has bought a large tract of land on the main line of the Boston & Albany R. R. and will at once build a large plant to meet the requirements of its increasing business.

Cutler-Hammer Mfg. Co., Milwaukee, Wis., maker of electric controlling devices will hereafter manufacture the Kohler system automatic push button control for printing presses, motor-driven tools, etc. This system was developed by Kohler Bros. of Chicago.

Globe Stove & Range Co., Kokomo, Ind., has largely increased its plant. It has installed a Newten cupola of 14 tons hourly capacity and an outfit of ladles and trucks for an industrial railway, all furnished by the Northern Engineering Works, of Detroit, Mich.

Ready Tool Co., Bridgeport, Conn., has engaged Mr. G. C. Parker to act as its sales manager. Mr. Parker has been for the past three years connected with the William J. Smith Co., New Haven, Conn., and has had successful experience marketing machine shop accessories.

Westinghouse Machine Co., East Pittsburg, Pa., held its annual meeting of stockholders June 21. The orders received for shop products during the fiscal year ending March 31 aggregated $5,123,612.23, an increase of $2,322.536.88 as compared with the previous fiscal year.

C. W. Hunt Co., New York, builder of coal handling, conveying and hoisting machinery, has opened offices in State Bank Bldg., Richmond, Va., and also at 607 Rhodes Building, Atlanta, Ga., with Mr. W. F. Lee, for several years preliminary engineer to the company, in supervision.

Peerless Automatic Machine Co., Cleveland, Ohio, manufacturer of automatic screw machines, was recently burned out, the loss being $15,000, partly insured. The company will erect a new plant immediately, and expects to be ready to handle business again in about ninety days.

Penberthy Injector Co., Detroit, Mich., numbered its 600,000 Penberthy automatic injector on March 29, 1910. It is estimated that 600,000 size G G injectors would handle about one-third the amount of water flowing over Niagara Falls, or approximately 2,520,000,000 gallons per hour.

Crocker-Wheeler Co., Ampere, N. J., at a recent meeting of directors, elected the following officers: President, Schuyler Skaats Wheeler; first vice-president, Gano Dunn; third vice-president, Arthur L. Doremus; chief engineer, Gano Dunn; secretary, Rodman Gilder; treasurer, W. L. Brownell.

LaSalle Machine & Tool Co., LaSalle, Ill., manufacturer of surface grinders and foot presses, has contracted for an addition to its plant, 48 x 95 feet, which will practically double the capacity of its shop built only a little more than two years ago. The construction calls for the completion of the new addition August 1.

G. M. Yost Mfg. Co., Meadville, Pa., has purchased the plant and equipment of the Williamson Vise Co., Bradford, Pa. The entire outfit of the Williamson Vise Co. will be moved to Meadville and the G. M. Yost Mfg. Co. will make a complete line of vises for machinists, patternmakers, wood-workers, jewelers, blacksmiths, and toolmakers.

M. L. Andrew & Co., Cincinnati, Ohio, manufacturer of wood-working machinery and multiple-spindle drills for metal drilling is now located in its new factory, corner of Colerain Ave. and Alabama St. The new location gives the company excellent facilities. The plant has been thoroughly equipped with modern tools and the output will be greatly increased.

Jacobs Mfg. Co., Hartford, Conn., chuck maker, has posted a notice to the effect that its factory will be closed the first week in August, and its employes who have worked nearly as full time as possible up to August 1 will be given a vacation for a week with full pay, paid in advance. In order to fill orders, it will be necessary for the plant to run Saturday afternoons until August 1.

Cooper-Hewitt Electric Co., New York, has recently purchased the substantial structure located on the corner of Grand and 8th Sts., Hoboken, N. J., for the manufacture of Cooper-Hewitt electric lamps. The new factory will be fully equipped with modern machinery and devices for the manufacture of the lamps. The plant is four-story and basement, the total space being 60,000 square feet.

Reliance Electric & Engineering Co., Cleveland, Ohio, announces that its armature shifting type of variable speed motor will be known as the Reliance adjustable speed motor instead of the Lincoln variable speed motor as formerly. This change is made necessary in order to better describe the type of motor in accordance with the present standard terms adopted by the American Association of Electric Motor Manufacturers.

International Acheson Graphite Co., Niagara Falls, N. Y., has adopted the name "Gredag" for its graphite grease in order to distinguish it from other grease products which contain impure natural graphite. The graphite blended with high-grade grease is an electric furnace product, exceedingly pure. The graphite is soft and unctuous and is a perfect lubricant in itself. It is claimed that in "Gredag" all the merits of graphite and grease are combined, making a lubricant of high quality and value.

Cincinnati Planer Co., Cincinnati, Ohio, has completed the removal of machinery to its new building at Oakley, a suburb of Cincinnati.